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LOOKING BACK AT MALTHUS*

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A fondness for poring over census figures that has lasted now for a quarter century has given me somewhat definite impressions of the trends of population growth.

Most census counts, as it happens, began with the nineteenth century. Sweden and Finland made their start in the middle of the eighteenth century, and Denmark, Norway, and Spain followed within twenty years (see Table I). Possibly we flatter ourselves when we indulge the notion that the United States fixed the practice. To set up the representative government that we had in mind it was necessary to count the people to be represented and to repeat the count at regular intervals. We have done it every ten years since 1790, the Civil War having come conveniently between census dates, though Reconstruction seriously vitiated the count in the South for 1870.

Whatever influence we may have had on others, most civilized countries soon began to count their people and have kept it up more or less regularly ever since. One may assert that the habit of regular census taking has become a sort of earmark of progressive and well-managed countries. Many countries, of course, are quite uncounted today. We do not know how many people there are in the world.

TRENDS OF POPULATION GROWTH

The simplest way to show the trends of population growth in the best-counted western countries is to set forth their annual percentage of increase through the century (see Table II). These 273 million people are believed to be about a sixth of the inhabitants of the world—the only people who have been counted through a whole century. The countries are not of equal weight statistically, as the present numbers in the last column show.

*Read at the Annual Meeting of the Association of American Geographers, Washington, D. C., Dec. 30, 1924–Jan. 1, 1925.

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The first four countries include eight times as many people as the last five. Moreover, the United States has received 33 millions of immigrants that these and other European nations have lost and therefore shows migrational as well as biologic growth.

TABLE I—EARLIEST CENSUS DATES AND NUMBERS OF ENUMERATIONS FOR EUROPEAN COUNTRIES*

DATE	COUNTRY	NUMBER OF ENUMERATIONS	DATE	COUNTRY	NUMBER OF ENUMERATIONS	DATE	COUNTRY	NUMBER OF ENUMERATIONS
1749	Sweden	34	1810	Prussia	30	1846	Belgium	9
1751	Finland	29	1818	Bavaria	25	1850	Hungary	11
1709	Denmark	15	1818	Austria	18	1856	Greece	8
	Norway	13	1821	Ireland	11	1859	Rumania	7
	Spain	11	1830	Holland	10	1861	Italy	6
(1790	United States)	(14)	1832	Saxony	23	(1869	Argentina)	(3)
1801	France	21	1834	Serbia	17	1871	German Empire	10
	England and Wales	13		Württemberg	21		(Canada)	(6)
	Scotland	13	1837	Switzerland	9	1880	Bulgaria	8
			1841	Portugal	10	1897	Russia	1

* Only eight countries date their census as far back as 1800; only sixteen as far back as 1850. Turkey has never had a census at all. The very remarkable census of Sweden was taken every year for the first three years, then every three years till 1860, since which time it has been decennial. It is further remarkable—like the almost equally complete census of Finland, which was undoubtedly an outcome of Swedish culture—for having been taken invariably on December 31 throughout its long history of 170 years. Most censuses, like our own, have fluctuated between a variety of dates within the year.

In cases like these, where the facts of population growth are known, one finds increase the rule; persistent, almost unfailing increase. Even in India, in spite of famines, each census shows a larger population than its predecessor. In the long census series of Sweden there is a single decrease of population of 35,000 between 1805 and 1810. So there was in Finland in that same period, and also a second of 74,000 in 1865–1870. The apparent exception to this rule of constant growth is Ireland. She had eight million inhabitants in 1841 and now has less than four. This, however, merely means that we must look outside of Ireland for most of the Irish. It is not a biological failure of Ireland to grow. There is no lack of Irish. We have a good many of them in the United States. Emigration has removed the Irish from their land, and emigration has shifted enormous masses of people all over Europe, though no other country shows effects so great as this.

TENDENCY OF RATE GROWTH TO SLOW DOWN

Next to the universality of growth I find most striking the tendency in the larger countries for the rate of growth to slow down. In our own case,

between 1800 and 1820 our population increased from 5.31 millions to 9.64, an increment of 4.33 millions in twenty years, or 216,000 a year, 4.08 per cent of the 5.31 millions at the beginning of the period. At 4 per cent a year twenty-five years growth would double the population. But

TABLE II—ANNUAL PERCENTAGE OF GROWTH OF POPULATION FOR COUNTRIES COUNTED FOR A CENTURY

COUNTRY	1800–1820	1820–1840	1840–1860	1860–1880	1880–1900	1900–1910	POP. IN 1910
United States . .	4.08	3.85	4.21	2.97	2.52	2.10	92,000,000
United Kingdom .	1.56	1.38	.45	.98	.91	.91	45,000,000
France*	.58	.59	.38	.22	.14	.19	39,000,000
Germany*		1.15	.73	1.04	1.26	1.53	63,000,000
Spain	1.25	.60	.35	.40	.50	.72	20,000,000
Norway	.50	1.51	1.32	.86	.93	.75	2,000,000
Sweden	.51	1.07	1.15	.91	.62	.75	5,500,000
Denmark	.96	.84	1.26	1.12	1.15	1.26	3,000,000
Finland	2.07	1.13	1.04	.90	1.58	1.48	3,000,000

* Less Alsace-Lorraine.

in the next twenty years the percentage fell to 3.90. From 1840 to 1860 it rose again to 4.22, but since that time it has fallen steadily to 2.98, 2.52, and 2.10. The last period is taken of ten years only, in order to stop before normal tendencies were interrupted by the war. At the century end our period of doubling had extended itself from twenty-five years to nearly fifty. All these American values are unique in magnitude among the data, as the table shows. Half of the increments are of less than one per cent. Moreover, this large but strongly declining American rate of growth falls in a period during which 33 million immigrants have come to our shores. Not all in one generation, of course. All of the early immigrants were dead before the last ones came, but their numbers were more than replaced by their offspring. But the inclusion of the immigrants must be noted. The large growth is not biological growth of the United States, and the falling off in growth was much greater than appeared in the figures because it was precisely in the latter years that immigration was largest. Another factor that has tended to mask the diminution of our rate of growth is the decrease of mortality through the century, which keeps many alive at modern censuses who would not have survived to be counted under earlier conditions.

For the United Kingdom the annual increment has never reached two per cent, and the same general falling off of the rate of increase is evident. Emigration here works against population increase. Some 16 million British subjects have left the kingdom for places out of Europe. Attention has already been called to the diminution of Irish population from this cause. That undoubtedly tended to depress British figures of population growth,

though the Irish decrease of population has been very moderate since 1880. England and Wales alone show the same slowing down of the rate of increase but give values more regular than does the Kingdom as a whole, the six percentages being: 1.75, 1.63, 1.31, 1.47, 1.26, 1.09.

If we could attach any value to early *estimates* of British population—5,450,000 for 1650 and 6,400,000 for 1750, for England and Wales—there has been an enormous acceleration of growth with the coming of the age of industry, the agricultural century 1650–1750 showing little more than a sixth of one per cent annual increment, while the industrial century 1750–1850 averaged 1.8 per cent. There are indications that the industrialization of any country has a tendency to increase its population greatly. But the nineteenth century has seen England's rate of increment decline again.

For France the facts are notorious. The rate of increase of the population is approaching zero. The population is already stagnant and threatens an immediate decline. The annual percentages record this fact; 0.58, 0.60, 0.46, 0.22, 0.14, and 0.19 for 1900–1910. These figures exclude Alsace-Lorraine, to use figures that are comparable before and after 1870.[1]

For the German Empire there are, of course, no figures before 1871; but values compiled for the equivalent area for 1816, 1837, 1858, and 1867 enable us to interpolate values for 1820, 1840, and 1860 that have interest, though the German figures have not the security of the others. One thinks he sees the prosperity and industrialization of the new Empire expressed in accelerated growth of population above the rate of agricultural days. The growth is accelerating to the end of the series. Signs that a turn has come now are that the rates from five-year periods show an annual figure for 1895–1900 of 1.56 per cent, 1900–1905 of 1.51, and 1906–1910 of only 1.41.

The Spanish figures are irregular, as are those of Finland. Norway and Sweden show a decline in rate of increase. Denmark shows a tendency to increasing rate in the only country in the world where agriculture has undergone a revolution in the hands of the farmers, and unquestionably more food is being produced from the same soil today than ever before, with the country resisting industrialization. In the previous century Denmark had an annual increment of 0.37 in 1769–1784, and 0.71 in 1784–1801. Sweden and Finland have values in the eighteenth century too between 1750, 1760, 1780, and 1800, making the whole Swedish series of increments, in hundredths of one per cent: 83, 50, 54, 50, 107, 115, 95, 63, 75. That of Finland is: 158, 176, 127, 207, 114, 105, 90, 158, 148.

Malthus Put to the Test

Now come echoes of Malthus and his alarm lest the rapid multiplication of population overwhelm civilization.

[1] The annual increments for Alsace-Lorraine are surprising. As they are not included in either France or Germany I give them here, putting asterisks for the value 1860–1880, the period of change of sovereignty: 2.07, 2.02, 4.29, ***, 1880–1890, 0.21, 1890–1900, 0.72, 1900–1910, 0.90. Big values under France, small values under Germany.

In 1798, when population counts existed only for Scandinavia and Spain with a single census of the United States, Malthus put on record his conviction—which his followers have erected into a law—that *Population, when unchecked, increases in a geometrical ratio. Subsistence only increases in an arithmetical ratio.* Looking about for facts to substantiate this doctrine Malthus finds his best support in the United States. "In the United States of America, where the means of subsistence have been more ample, the manners of the people more pure, and consequently the checks to early marriages fewer, than in any of the modern states of Europe, the population has been found to double itself in twenty-five years."[2]

This attracts a certain amount of attention because of the fact that the first enumeration of the United States was made in 1790, and only eight years had elapsed when Malthus wrote. The only base of Malthus' assertion must have been some estimate of population from colonial days.

But, as a matter of fact, what have the fourteen census enumerations shown about our increase of population? In what periods has it doubled its numbers? It doubled the numbers of 1790 in 22.6 years, again in 24.4 years, and twice more in 23 years and 30. That was 34 years ago, in 1890, and we are still 13 millions short of another doubling. To judge from the annual increments the doubling now in process will take 40 years or more. Had our population doubled in every period of twenty-five years, as Malthus asserted it was doing, we should have had 125,730,000 people in 1915. We actually had 98,000,000 at that date, over 27,000,000 short of his estimate. And this in spite of the fact that our biologic growth—the only sort of growth that Malthus considered—had been augmented up to 1915 by 33,000,000 immigrants, people so far beyond Malthus' horizon that the very steamships which brought them here were inconceivable in his day.

It is obvious that Malthus' reasonings were unsound. In spite of the support given to his estimates of purely biologic growth by a huge immigration, which, I repeat, was without example in those days and of which he could have no expectation, his estimates went far beyond the actual growth of our country because he was unaware of a tendency in population growth to slow up, which the future was to develop. It would seem self-evident that estimators of future population should base their estimates on the observed facts. Malthus could not do so, for the counts had not yet been made; but his successors have not utilized their opportunities. The United States Census of 1860 estimated the population of 1900 at 100 millions, possibly because it was such a nice round sum for a century end! However, when 1900 came there were but 77 millions present to be counted. So well-informed a man as James J. Hill estimated in 1906 that our population would be 117 millions in 1920. It was really less than 106, a falling off from the estimate of 11 millions in the brief period of fourteen years. All these estimates err on the long side. None of the men who made them seems to be aware that the rate at which population increases is distinctly

[2] Essay on the Principle of Population, etc., 1798, p. 20.

slowing up. Now that we are beginning to check the free entry of immigrants the slowing up will become yet more pronounced. The current estimates for 1950 or 2000 are certainly much too large.

Measured periods of doubling now known, but none of them made in Malthus' day, are for Finland, 49 years to 1800, 58 years to 1858, and something like 62 years the third time; for the United Kingdom, 70 years; for England, 45 years the first and 55 years the second time; for Sweden, 105; for Spain, 131; for Denmark, 91. France gives no sign of ever doubling. In the Argentine Republic the population has doubled from the 1,737,000 of 1869 in 21 years, a second time in another 21 years; but the third doubling is proceeding so slowly that it looks as if 50 years would be needed to complete it at 13,896,000 people. The estimate of population for 1921 is 8,700,000. In the Argentine, as in the United States, a large immigration has swelled the biologic increase—for the size of the country quite as large an immigration as ours.

Although Malthus stated that the conditions in the United States were more favorable than anywhere else, he used his "American" rate of increase —doubling in 25 years—as a normal one. To illustrate his arithmetical and geometrical ratios for instance, he estimated that the 7 million English of 1798 might become 14 millions in 1823 and their food become food for 14 millions; but in 1848 they would be 28 millions with food for 21 millions; in 1873 they would be 56 millions with food for 28; and in 1898 they would be 112 millions with food for but 35 millions, leaving 77 millions of people without food! Malthus arrives at an absurdity by arguing from premises that are untrue. England did not have 112 millions in 1898. With Wales it had less than 32 millions of people. If it had food for 35 millions it had more than enough.

Increase of Man and His Food Compared

Malthus' doctrine of the arithmetical ratio with which food increases has no foundation even in theory. If man, "unchecked," may double and quadruple his numbers, so may the plants that he uses for food, if similarly unchecked. "Linnaeus has calculated that if an annual plant produced only two seeds—and there is no plant so unproductive as this—and their seedlings next year produced two, and so on, then in twenty years there would be a million plants."[3] Food nowadays does not "increase" at all. Man produces it, stimulated by the hope of profit exactly as when he produces shoes or nails. If prices go up, he is likely to produce more; if down, he inevitably produces less. In producing crops man makes it his business to see that all possible checks are removed from their multiplication.

Darwin's own statement is a model of scientific opinion. "We may confidently assert that all plants and animals are tending to increase at a geo-

[3] Charles Darwin: The Origin of Species. London, 1886, p. 51.

metrical ratio."[4] No word of the hunger that Malthus in 1798 insisted was the imminent check to population. Indeed, Darwin wrote in 1859, "The causes which check the natural tendency of each species to increase are most obscure."[5] In fact, it appears to be the substance of his teaching that species of animals and plants are under the necessity of having an extraordinary power of reproduction just to maintain themselves in existence, so many are the dangers and enemies that threaten them with extinction, especially in the youth of the individuals.

The distinction between rates of increase of man and his food is not sound. Both are organic, and both show the same tendencies. What difference there is is wholly in man's favor since he is capable of foresight and plan while the organisms that he feeds on are not. He protects his crops and his flocks from the dangers and the enemies that threaten them. He had made beginnings of this long before Malthus' day by his science of agriculture and animal husbandry. Since then he has gone much further in his control of insect and fungus pests, but his chief means of increasing his food has been through the extraordinary development of transportation.

Malthus, living just at the beginning of the nineteenth century, was satisfied that "the power of population is indefinitely greater than the power of the earth to produce subsistence for man." Yet for a century and a quarter after Malthus food has certainly increased faster than mankind.

In 1798 men stood in a relation to their food that had changed little in centuries. Food was produced, in all but the rarest cases, near the place where it was consumed, and a very large proportion of mankind was engaged in producing it. Today it ordinarily comes hundreds or thousands of miles to our tables and is produced by a special, distinctive class of workers—the farmers, a smaller and smaller proportion of all the workers in the more civilized countries. In those days the world was overwhelmingly agricultural, even in Europe and the United States. The physician, the minister, the judge, the merchant, and even the pedagogue had farm or garden and raised no small portion of his family's food. In 1798 the mass of mankind gave the main effort of their lives to winning food for themselves and family directly from the ground. Most men in those regions now, or the more progressive, industrial part of them, work at making other things—what Mr. Strauss calls "things in the saddle."[6]

Malthus did not know. He felt sure enough of many things. He thought and wrote much about the future but had no inkling of the new epoch that was about to dawn for men, the age of steam and steel, of engines and machines and motors, of capital organized, of tele-communication and transportation. And it was precisely these things, just on the modern side of his horizon, that have put food back into a minor place and have put things-not-food so much to the fore.

[4] *Ibid.*, p. 52.
[5] *Ibid.*, p. 53.
[6] Samuel Strauss: Things Are in the Saddle. *Atlantic Monthly*, Vol. 134, 1924, pp. 577–588.

The Campaign to "Eat More Food"

One of the newest things in this old world is our iterative education by advertisers to "Eat More Food." Raisins began it, I think, when the California growers found they could produce far more than the American people was in the habit of eating. As an incident they popularized raisin bread. Then it was "Eat More Oranges," and we were told about the vitamines we needed and could get only in that way. The Brazilians, loaded with accumulated coffee crops, threaten a campaign to teach us that we can safely and with advantage drink more coffee. To dispose of the too abundant wheat of our own Northwest in 1924 we were urged to "Eat More Bread," and for those who had diversified and were abounding in dairy products we should "Eat More Butter." The Norwegians gather from the icy seas vastly greater crops of fish than they can hope to consume at home, even though they make three meals a day of it; and they take it to the Catholic lands of the Mediterranean, praying, good Lutherans as they are, for the continuance of Catholic fasting in those regions. But when Norway inclines toward total abstinence and would limit her use of Spanish wines, she is promptly told to drink more wine or the Spaniards will eat no more of their fish. Even the United States Department of Agriculture, in its zeal to do something for the farmer, has bulletins in the post offices suggesting that we eat a great variety of kinds and cuts of meat.

It is a campaign over wide areas to induce consumers to use more of the producers' crops of food. Food looking for people to eat it is a condition to be reckoned with in these days. We can produce food faster than people can eat it. It has become like the output of a factory. We should be glad to produce more if there were more buyers, *and we could easily do it!*

A bumper crop is now a disaster. Congratulate a farmer on the biggest potato crop of a generation, and he doubts if it will pay to dig.[7] The only relief for the Northwest, where the wheat crop was too abundant, came when it was learned that the crop in some parts of the world was distinctly short after all.

How can it be possible for men to thrive on short crops and be ruined by abundance? Time was when large crops brought universal prosperity and rejoicing. Had not Thanksgiving Day just that origin?

What achievement of our mechanical and industrial age is more distinctive than that it has relegated food, i. e. *food as nourishment*, to a subordinate place among the objects for which men labor?

As near as I can learn there was no road in the world in Malthus' day on which vehicles were moving goods at six miles an hour. On the sea, when things went well, double that speed might be made. Today millions of tons of wares are always moving about at ten to twenty miles an hour, and thousands at speeds much higher.

[7] This is now the case in northern Michigan.

The Crops of Today Money Crops

The crops of today are not merely transported crops, they have also become money crops. Today a farmer almost refuses to count at all the food consumed on his table if he raised it himself. Russians, colonizing the Brazilian backwoods a century after Malthus, produced food crops in great abundance but, in the roadless impossibility of getting them to market, abandoned their settlements for the open plains of the Argentine. But did not the pioneers in the American forests put up with just that sort of privation? So far from finding their condition desperate, the settling of the region often sent them off anew in search of another frontier. By all accounts their money crops were few.

The markets of the modern money crop are remote. The farmer has little knowledge of them. His only index of success in his labors is the price he gets. Of this price and the elements that combine to fix it he has so little understanding that he is ready to listen if you suggest that avaricious men depress it to deprive him of a return for his labors. Fortunately the fluidity of the stock of wares in the modern world is so great that such artificial price making is very difficult. A low price indicates poor farming nowadays, so greatly is the farm concept changed. A high price indicates good farming. So the Danes judged it. When steam transportation began to bring to Europe the grain from American prairies the price of Danish grain told them their farming was bad. They set themselves to produce butter as a better product for Denmark, not, I suppose, without plenty of hardship among Danish farmers in the transition; but a good price and steady for Danish butter tells them that they are farming well.

The universal production of money crops has created need for salesmen farmers. Where once the good farm was good soil with the right supply of water and a growing season long enough to grow a crop, now its most important attribute is nearness to a populous and wealthy market. Where the good farmer once was a man skillful in growing and harvesting crops, now he must above all know how to sell them. Success at selling a poor crop may bring prosperity, failure to sell a good one bankruptcy. And, similarly, poor soil badly watered near a large city makes a better farm than the best land in a solitude.

The best salesmen among farmers have sold their own crops and their neighbors' as well. Oftentimes the profits of salesmanship have taken them out of active agriculture into active business. They are the middlemen who capitalize their skill in selling. They do this to their own advantage. If combinations of farmers choose they may hire their services at the value of good salesmanship in the market. It is high.

The agriculturist who raises what he likes to raise and waits for buyers to come must not complain if he sees hard times. A money crop demands that some one go out and sell it.

Food crops become money crops have attracted money getters the world over, not to raise them but to move them, to buy and sell them for

profit. Transportation of food that results from knowledge of the world's markets has led to the making of fortunes. Naturally the fortunes went to those who put knowledge and initiative into the affair. They could not go to the raiser of the crop, whose part has been too often routinary. Still his routine labors have become possible on vast virgin territories by means of the middlemen's knowledge and initiative. He cannot complain that they have taken the fruits of his labors away from him. They have given him the possibility of doing business as he prefers to do it.

The Fear of a Food Shortage

Farm machinery has made other fortunes and employment for many men at good wages. Food advertising and food selling have doubtless come to stay, for they profit those who carry them on. The result has been abundance of food. Men's effort for profit has given every one better food and more abundant than ever before. Not hunger has driven them at all. The same desire of profit will yet make practicable for us the fixation of atmospheric nitrogen for fertilizers. It may yet give us synthetic foods. It will certainly affect our food supplies in ways we do not dream of. We have no reason to suppose that hunger will be the motive that drives us to these things. Hunger has become rare in the world. It is difficult for it to survive the glare of publicity, in the abundant stores of food and the speed of transportation, so eager are the well-to-do to feed those who are in want. When the cables announce that millions are starving in Russia, other millions send them food and still have abundance to eat at home. Furthermore, as is well known, the check of population growth, or the diminution of the size of the family is most pronounced in the more prosperous classes, those precisely from whom any fear of hunger is most remote. Instead of doubling their population with every quarter century the countries that thrive show a growth so hesitating that the doubt arises whether they will be able to maintain themselves in the face of their enemies, whether they are not in danger of national suicide. Yet there are thoughtful men today who tell us they share Malthus' alarm lest men become too numerous to find food on the earth. They admit the present amazing increase in the supply of human food but think we must regard it as something of an accident that cannot be repeated. "The industrialization of the Caucasian world which has gone on at such a rapid pace during the last fifty years has provided for more people, it is true. In fact population increase, though rapidly rising, has not really caught up with the increase in production made possible by the multitude of mechanical inventions. But why has this come about? There is one reason and only one reason for the situation. We have had a reserve of new land to draw upon."[8] How similar this to the lament of Tertullian in the beginning of the third century: "Most pleasant farms have obliterated all traces of what were once dreary and dangerous

[8] E. M. East in *World Agriculture*, Vol. 2, 1922, Amherst, Mass.; ref. on p. 130.

wastes; cultivated fields have subdued forests; . . . sandy deserts are sown; . . . marshes are drained; and where once were hardly solitary cottages are now large cities. . . . Everywhere are houses, and inhabitants, and settled government, and civilized life. What most frequently meets our view is our teeming population; our numbers are burdensome to the world, which can hardly supply us from its natural elements."[9]

Tertullian did not know what time was to bring forth. Dr. East does not know what the future has in store for us, but he might learn that population increase is not rapidly rising but instead distinctly slowing its rate. And it should not be hard to believe that men will further increase their powers over their environment. Up to the present that process has been strongly accelerating in the sense that more progress is often now made in ten years than formerly in hundreds. This very acceleration in man's conquest of nature is disquieting to Dr. Raymond Pearl.[10] Are we not overdoing everything? Surely we cannot go on like this—while the world's population increases (in a century) only two-and-a-half times, augmenting our iron output 50- to 70-fold, our cotton 20-fold, our shipping 8-fold, our railway mileage by 17,000-fold, and our telegraphs 300-fold! It is true we use up resources that we miss later. Our forests are largely gone. Our coal and our copper seem likely to come to an end, though substitutes are in sight. However, the comparisons Pearl makes would be less alarming if put somewhat differently. New powers have a tremendous expansion in their infancy and later slow up as world needs approach saturation. Automobile output will some day slow up a bit when the main world demand has been satisfied. In the first period, however, the rate of production rises with tremendous rapidity, to slow down later. So these new developments that he cites increase in their first years vastly more than mankind whose beginnings lie far back in the mists of time. If we could divide the life of mankind into ten equal periods of time, and similarly the period of active exploitation of iron and cotton and shipping and railway building and telegraphs, it would be instructive to compare the rate of expansion of each in the latest tenth of the period involved for each. If the cotton period dates from 1800, the railway period from 1830, and mankind from a hundred thousand years ago, the last tenths would date back ten thousand years for man, twelve years for cotton, and nine for railways; and the comparison would lie between the increase of men in ten thousand years, of cotton production in the last twelve years, and of railway building in the last nine. The results would be less discordant.

The Luxury Check

But, if there is no ground for expecting an indefinite increase in the numbers of men on the earth, and if it is true that we are now and may always be able to supply everybody with abundant food, what is the agency that

[9] Quoted in A. M. Carr-Saunders: The Population Problem, Oxford, 1922, pp. 19–20.
[10] Raymond Pearl: The Population Problem, *Geogr. Rev.*, Vol. 12, pp. 636–645.

is now beginning to check human expansion and that may be relied on to keep the future number of mankind within limits? It appears to be the growing desire for luxurious living. Even the general mass of mankind among us are beginning to spend more for other things than for food. Free loaves were an enormous bounty in ancient Rome. They would be a trifling one today. A committee of the Senate reported in 1895 that in a "normal" workingman's family—husband and wife and not more than four children under fourteen—an average from thousands of budgets showed that 41 per cent of all family expenditure was for food. A recent investigation by the Department of Labor gets an average for 12,096 families of 38 per cent for food. The proportion appears to be diminishing. "Things are in the saddle" in these days, and it is increasingly difficult for men in average or better than average circumstances to keep up with their neighbors in dress, in housing, in automobile expenditure, and in social expenses. Not at all in food. If our grocer's or butcher's bill alarms, it is food-for-entertainment, food-as-display, and food-as-luxury, not food-for-nourishment that we have bought. Those families in which food-as-nourishment is a matter of course, a very minor expenditure, are almost certain to be families without children or with few children. If there are people in the world who lack sufficient food, their families are likely to be not small. They are contributing to the increase of the race in spite of any pressure hunger may exert upon them. The falling off comes almost exclusively from those to whom hunger is unknown. It is a complete reversal of Malthus' doctrine. Population is effectively checked already among the more prosperous nations and especially among the more prosperous members of those nations. "Become civilized, become cultured, enter the social swim, and commit suicide to your race; have no children, for they are a great trouble and a hindrance to your career"—this was the theory and practice that Roosevelt regretted to see abroad in our land and in the world.

This is far from any thought that Malthus entertained. It is a luxury check now operating among the so-called progressive nations. It seems likely to become more and more widely effective throughout the world as the missionary forces of Consumptionism teach all the world to want more things, teach every one the Consumptionist doctrine that to be supplied with food, shelter, and clothing alone among material things is to lead a dull life, dull to the point of intolerability. The doctrine tends to spread and may yet claim all continents for its abiding place and all men for its votaries.

We see these tendencies, and that is as much as is permitted us. We do not know what the future will bring forth.

Predictions of the population of the future are equally impossible. The current ones do not even give heed to present tendencies. We do not know what future population will be. Such numerical data as we have of the facts of the last century suggest a progressive slowing up of population the world over. The very definite intention in the United States to have fewer

additions by immigration shows the same sort of feeling as the diminishing size of families. We want to keep up our "scale of living." We want more, not less, of luxury and pleasure; and this desire is more real as a check on population in the more civilized countries than hunger is. There is no indication of increase at geometrical ratios in census figures. It is entirely possible that the mass of men may always be sufficiently or even abundantly fed on our planet.

If the population of the earth has doubled in the last century, which we do not know, for great numbers of men have never been enumerated as yet, it is entirely reasonable to expect that they will not double in the next.

ANCIENT TRADE ROUTES FROM CARTHAGE INTO THE SAHARA

By Count Byron Khun de Prorok
General Director of the Excavations of Carthage

The new excavations now in progress at Carthage[1] have revealed many objects and elements strange to the Phoenician culture of the ancient city. In the Temple of Tanit have been found works of artistic design purely Egyptian; some of the objects discovered are of origin unknown; others probably derive from the interior of Africa.

It has been frequently pointed out that, great as is the obstacle imposed by the Sahara, it has never been a complete barrier to intercourse and in prehistoric times probably was less so than today. Gsell describes North Africa (Barbary) as a veritable island, "the Isle of the West," as the Arabs say, surrounded by the Mediterranean Sea, the Atlantic Ocean, and a "sea of sand."[2] The establishment of the Phoenician colonies, especially Carthage (800 B. C.), on the Mediterranean coasts of Africa must have greatly stimulated a trans-Saharan trade which archeology indicates was already in progress; and we can imagine that a special impetus must have been given by the famous voyage of Hanno to the western coast of Africa in 550 B. C., as is related in the Periplus of Scylax the Greek. For the trans-Saharan traffic in gold and precious stones, ivory and elephants, and slaves, Carthage was the central outlet. It remains for us to trace the routes of this old trade.

Modern means of scientific exploration are now opening up to the geographer and archeologist areas that hitherto have been difficult and dangerous of access. Especially is this true of the automobile and airplane. The great explorers of Africa, such men as Barth, Rohlfs, and Duveyrier, were intrepid pioneers; but their researches were restricted because of the slow rate of travel by camel and because of the antagonism of desert tribes, now for the most part subjugated. Many an expedition sent out to explore the Sahara has met death at the hands of the Tuaregs. A terrible disaster was that which overcame Colonel Flatters' expedition when 90 men perished (1881). In the course of our work the coming season we hope to bring back specimens of the extremely poisonous desert plant (*Hyoscyamus falezlez*) which, mixed with dates and given by treacherous natives to the ill-fated expedition, contributed to the final disaster. It was only in 1916 that Father Foucauld was massacred by Tuaregs at Tamanrasset on the southern edge of the Ahaggar. The conquest of the desert by modern means of locomotion was been described by E. F. Gautier in the preceding number of the

[1] See the author's paper: Recent Researches on the Peninsula of Carthage, *Geogr. Journ.*, Vol. 63. 1924. pp. 177–189.

[2] Stéphane Gsell: L'Algérie dans l'antiquité, new edit., Algiers, 1903, p. 18.

FIG. 1

FIG. 2

FIG. 1—Panorama over the site of Roman Carthage.

FIG. 2—The end of the Roman road that in antiquity reached the island of Jerba by a causeway now submerged. In summer the water is low enough for camels to cross, whence it is known to the Arabs as the "camel bridge."

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FIG. 3—Carthage in relation to the Sahara. Above: map of Tunisia showing Roman roads (according to Tissot, with additions from Müller). Scale 1: 5,000,000. Below: map of northern Africa to show situation of Carthage in relation to the Sahara as a whole. Scale approximately 1: 50,000,000.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—The amphitheater of Thysdrus (El Jem), one of the finest monuments of Roman rule in North Africa.
FIG. 5—Traces of the Roman road at Tacape (Gabès).
FIG. 6—In the country of the Matmatas (south of the road from Gabès to Médenine). Here are prehistoric caves, the "eagle's nest," and cave dwellings of the modern Berber inhabitants and—a symbol of the peace that has rendered these refuges unnecessary—the French garrison.

Geographical Review.[2] But the conquest still seems only partial. M. Gautier reminded us of the tragic death of General Laperrine in an airplane accident in the Adrar des Iforhas in 1920. The latest news concerning the widely advertised plan of an automobile tourist route to Timbuktu is that M. Citroën has been compelled to abandon it because of the attitude of the Saharan tribesmen.

But, whatever the fate of commercial trans-Saharan schemes, the auto-

FIG. 7

FIG. 8

FIGS. 7 and 8—The strange many-storied dwellings of Médenine, known as *ghorfa* (see reference in footnote 8).

mobile will become an indispensable adjunct to scientific expeditions. The saving that can be effected by its use is immense. What it took Duveyrier and Colonel Flatters ten weeks to traverse can now be done in as many days. Our task, however, is to explore methodically the ground that is crossed. Twenty years ago a detailed scientific study of the great central plateau of the Sahara, the Ahaggar, would have been impossible. It is our hope to explore methodically and progressively this little-known region.

To comprehend the importance of Carthage as a center of routes to the interior one must realize its situation in relation to the Ahaggar massif and the depression of Fezzan lying between this and the Tibesti massif. The route of Fezzan offers the best natural road to the Sudan as regards topog-

[2] E. F. Gautier: The Trans-Saharan Railway, *Geogr. Rev.*, Vol. 15, 1925, pp. 51–69.

raphy and water supply. One cannot do better than quote the following summary:

For trans-Saharan communications the Fezzan offers the most important historical route after the Nile. An intimation of this is to be found in the persistence of the ancient geographical names—Mons Ater, Phazania, Jerma [Garama], which preserves the illustrious name of the Garamantes; and on the events which explain this persistence we have historical light. The Syrtes were almost completely under Carthaginian dominion, and it is clear that the Carthaginians were interested in trans-Saharan commerce. Herodotus, five

FIG. 9

FIG. 10

FIG. 9—The Punic mausoleum at Dugga, restored by the Service des Antiquités.
FIG. 10—The capitol of Thugga (Dugga).

centuries before Christ, knew the road of Fezzan. The Roman Empire, successor of Carthage, exercised more or less control over Phazania; time and again it sent thither military expeditions. History has preserved the record of two Roman expeditions that pushed their way through Fezzan to the country of the hippopotami. The Empire left archeological monuments there as far south as Garama (today Jerma), the ancient capital of Fezzan.

Pliny gives us detailed information concerning the two roads which still connect Tripolitania and Fezzan. The longer and easier, because it is well furnished with sources of water, passes by Sokna and Mons Ater. The Romans under Vespasian in 70 A. D. discovered another route to the west which reduced the journey by ten days but which was much harder. This is the route from Tripoli to Murzuk followed by Barth, who crossed the solitudes of the Hammada el Homra. All this is perfectly definite knowledge. This country, whose existence for two millenniums has been bound up with its situation on a highway,

naturally offered its facilities to European explorers. It was by Fezzan that Barth succeeded in carrying out the first scientific journey across the Sahara to the central Sudan. After him Rohlfs, Duveyrier, and Nachtigal were cordially received in the Fezzan and sojourned there. It is the most open part of the Sahara.[4]

Carthage to Ghadames by Gigthis

On the western border of the Fezzan between Jerma and Carthage lies Ghadames, the ancient Cydamus subdued by the Roman Balbus in his march on the Garamantes. There is no doubt that Ghadames has been a great trading center from earliest times. Duveyrier found there Egyptian sculptures and believes that the place has been inhabited since its prehistoric foundation.[5] He speaks with great admiration of the enterprise of its inhabitants, the organization and extent of the trans-Saharan trade in evidence at the time of his visit.

Last year our expedition visited the probable routes and trading posts between Carthage and the desert. The first of these routes led via Gigthis to the south of the Gulf of Gabès. This section constituted a part of the great Roman road of the littoral running west and east of Carthage to the farthest extremities of Roman Africa. Regarding it and the other Roman roads in Africa two priceless documents have come down to us from the later days of the Empire, the Antonine Itinerary and that known as the Tabula Peutingeriana. The former gives the distances and positions of stations along the roads and resting places (*mansiones*) but omits intervening towns or villages. The Peutinger table gives all the military roads, the stations and cities, temples and baths and storehouses on the way. In some instances the two documents supplement each other, the Antonine Itinerary, for instance, giving data for the Tunisian interior (Byzacium) and the Syrtian Sea area where the Peutinger table is deficient. Tissot[6] has discussed the identification of the roads in the Tunisian region on these and other bases, and more recently they have been interpreted by Konrad Miller.[7]

From Carthage our road, avoiding the protuberance of Cape Bon, proceeds south to the Roman Putput, whence it runs along the shore by the ancient Aphrodisium, Hadrumetum (Susa), Leptis Minor, and Thapsus. Thence the main highway runs through Thysdrus (El Jem), one of the chief foci on the route, no less than six roads meeting here. Before Gigthis is reached we pass the important station of Tacape (Gabès) and the port for the lesser Syrtis (Gulf of Gabès).

The Roman road is visible every few miles along the way, and many old bridges and milestones are to be seen. The milestones are particularly illuminating. They stand solidly upright in heavy stone bases. At the head is often the name of the emperor under whose rule the stone was erected;

[4] E. F. Gautier: Le Sahara, Paris, 1923, pp. 134–135.

[5] Henri Duveyrier: Les Touareg du Nord, Vol. 1, Paris, 1864, pp. 249–266.

[6] Charles Tissot: Géographie comparée de la province romaine d'Afrique, 2 vols., Paris, 1884, 1888; reference in Vol. 2, pp. 51–710.

[7] Konrad Miller: Itineraria Romana, Stuttgart, 1916.

FIG. 11

FIG. 12

FIGS. 11 and 12—Ruins of Thugga (Dugga) in the midst of century-old olive trees. Thugga lay slightly off the military road from Carthage to Theveste.

FIG. 13

FIG. 14

FIG. 13—The great ruins of Thuburbo Majus now being excavated by the Service des Antiquités.
FIG. 14—The fine Roman bridge at Sufetula (Sbeitla).

FIG. 15

FIG. 16

FIG. 15—The three temples of Sufetula (Sbeitla). Little is known of them: they were probably dedicated to Jupiter, Juno, and Minerva.

FIG. 16—Triumphal arch of Sufetula (Sbeitla) erected under Diocletian.

then come the distances to and from a great center, often Carthage. The date of completion of the road is given, and the carrying out of improvements under such and such an emperor. The inscriptions also give a list of the difficulties to be encountered ahead—marshes, mountains, torrents,

FIG. 17—Reconstructed Roman bridge in the Selja, a route leading to the Sahara.

waterless stretches, etc., and they indicate the class of road, whether a main highway or a local artery.

The route to Gigthis, however, was Phoenician before it was Roman, and on the way we pass the Punic emporia on the sites of the present Mahdia, Slakta, and Tina (Thenae). Ancient Gigthis itself was the halfway city to Oea (Tripoli), Leptis Magna, and Cydamus (Ghadames). The country immediately south of Gigthis offers much of interest in human geography both ancient and modern. Here, for instance, are the curious and often described cave dwellings.[8] At Médenine there are cell-like houses several stories high, and at Matmata there are houses having several stories underground. Matmata occupies a defensive site in the hills.[9] A French fortress

[8] See note on "The Rural Habitations of Tunisia" in this number of the *Review*.

[9] Cf. J. Russell Smith: The Desert's Edge, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 813–831.

has been established there near the Roman outpost of antiquity facing Tripolitania and the Sahara. North of Gigthis lies the island of Jerba (the ancient Meninx), in ancient days reached by a causeway four kilometers long (see Fig. 3). Today, as then, its cultivation is in most flourishing

FIG. 18—A gateway to the Sahara: the gorges of Selja.

condition, thanks to the industry of its inhabitants. The island and the adjacent mainland were the land of the lotus eaters. From Gigthis traces of ancient ruins and routes are seen leading south across the mountains from the Jebel Dwirat in the direction of Ghadames and the farthermost Sahara.

In identification of the old trade routes attention should be called to the importance of the water sources, though of course some have been dug more recently and some have been filled in. To colonize northern Africa in antiquity, as today, two things were essential—water and means of communication. In the summer months there is very little rainfall. The vast constructions built by the Romans and still standing seem to indicate that the climate has not changed materially in twenty centuries. At Carthage the "Cisterns of the Devil," as they are called by the Arabs, are still used: they hold millions of gallons of water. On our way south we passed many aque-

ducts of beautiful workmanship, notably at Aphrodisium and Sbeitla (on our second route). Between Carthage and Mt. Zaghwan there is an aqueduct 90 kilometers in length that used to carry six million gallons of water a day to the metropolis, supplying a population of 500,000 souls.

Carthage to the Sahara by Sbeitla and Nefta

It was by this great aqueduct, passing the Roman Uthina and Thuburbo Majus on the way, that we took our second route out of Carthage to the desert. Both the cities mentioned are at present being excavated by the Service des Antiquités, and a rich harvest is being reaped. From Thuburbo Majus the old road leads to Sbiba, the ancient Sufes, then to Sbeitla, the ancient Sufetula. The road now passes through a veritable park of ruins, an open-air museum, with a succession of splendid edifices silhouetted against the blue background of the African sky. Parts of the Roman road are in an excellent state of preservation here. The next great ruins are those of Cillium (Kasserine) and Thelepte. Here a portion of the road recalls the Appian Way near Rome, for it is lined with tombs.

Various methods adopted by the Romans for the protection of the roads are illustrated in this section. In one place, for instance, where the earth is clayey and easily washed away retaining walls have been built that throw the water into sluices passing under the road. In some places dams have been built to keep the rivers in check. South of Thelepte the road runs through the wonderful gorges of Selja, called by the Arabs the gateway of the Sahara. In their colors the gorges recall the Grand Canyon of the Colorado, and their fantastically carved walls have caused them to be cursed in the legends of the Arabs. The Roman road disappears on the side of the gorge, but we can trace remains of a Roman aqueduct that carried the waters of the Selja River into now waterless desert country. There are prehistoric sites in the gorges of Selja and the mountains around Gafsa, Tamerza, and Redeyef. The Carthaginian Exploration Society is undertaking a separate expedition to excavate and explore them.

The route now approaches the edge of the Sahara and leads to Nefta (the ancient Nepta) and to Tozeur (the ancient Thusurus), the region where in early times dwelt the famous tribes of the Gaetuli.

Nefta and Tozeur are on the border of the region of the great shotts, the legendary Lakes of the Tritons. It is thought that the lakes once connected with the Gulf of Gabès: the mouth of the river of the Tritons (now known as the Wad Malah) is placed near Gabès. Nefta has been named by the Arabs "Mesra-es-Sahara" (Port of the Sahara). This may once have been true literally, as it is now figuratively. Tissot[10] speaks of the remains of a Roman galley found by the Arabs in the Shott el-Jerid. He also gives an effective description of the crossing of the lakes, very difficult except in summer when they dry up. In 1306, Tijeni, the Arab historian, recounts

[10] Tissot, *op. cit.*, Vol. 1, p. 135.

FIG. 19

FIG. 20

FIG. 19—Ruins at Ad Majores, a military station established under Trajan on the threshold of the Sahara.
FIG. 20—Camp of the expedition on the sand that covers the site of the ancient Nepte (Nefta).

the tale of a caravan of a thousand camels being swallowed up in a few minutes in the crossing of the vast marsh. The solitude and desolation of the region is appalling, and the scores of camel skeletons we passed on the way down heighten the awful aspect. The region is about 60 feet lower than the level of the Mediterranean Sea, from which it is separated by a space of about 20 miles only. De Lesseps conceived the idea of flooding the shotts, but his chimerical project was abandoned for it would have meant the destruction of the flourishing oases of Nefta and Tozeur with their thousands of date palms.

We spent several days in investigation of the shotts, and it is hoped that during the prosecution of the long series of researches now in hand the question of the date of the desiccation of this part of Africa may be determined. At present the vexed question permits of no definite conclusion, but I believe that it can be solved by archeological study.

We camped at Nefta on a dune that completely covers the city of antiquity. The dunes here are ever changing, making study of the old civilizations difficult. At present a great mass of sand is approaching and it looks as though the modern town might suffer the same fate as its Roman predecessor. Here we concluded our second route, one of immense interest because of the wealth of ruins along its course. From Carthage to Nefta are the rich remains of no less than 36 towns, the majority entirely unexcavated.

Route via Tebessa

Our third route took us by way of the ancient Cirta (Constantine), an important commercial center under the Romans and a focus of roads. One of these leads to Tebessa, the ancient Theveste. All along the way mausoleums, Byzantine temples and fortresses, and Christian basilicas abound. This is the ancient Numidia, famous of old for its horsemen and today still famous for its olive plantations. A main military artery also led direct to Theveste, 275 kilometers from the "Gate of Theveste" at Carthage via Membressa, Sicca Veneria, Altiburos, and Ammaedara. A short distance southwest of Tebessa is the majestic gorge of Orfana, where every few miles were seen traces of the Roman road cut out of the living rock. The ruts scored by the wheels of the ancient chariots are still visible, and the Arabs today call the valley "Tric el Rareta" (Trail of the Wagons). The plateaus about Tebessa and the slopes to the great shotts are the country known to the Arabs as Nemencha. Today it is desolate and barren, though the numerous ruins attest a former prosperity, and here furthermore are rich deposits of phosphates. The old trail now reaches Besseriana, the ancient Ad Majores, near the modern oasis of Négrine. The architecture of the ruins, half buried in sand, is peculiar, suggesting a Carthaginian origin: further investigation is needed. There is also standing a beautiful triumphal arch built to the Emperor Trajan. Ad Majores seems to have been at a

crossroads of trails going south by El Wad to Ghadames and the Ahaggar and a road east to Gigthis.

Program of Further Work

Here then are three portals to the Sahara. Next season we shall take up the work of tracing the continuation of the ancient routes across the desert to the Ahaggar and the oases in the depression on its eastern border. A starting point will be Ghadames (the ancient Cydamus) whence routes lead east to Egypt and south to the mountains. We shall also visit Jerma,[11] the ancient capital of the Garamantes. An important task will be the photographing of the ancient rock sculptures of the desert depicting the caravans of antiquity. At Telizzarhen (Telisaghé) Barth saw remarkable sculptures with oxen and wagons complete. Other interesting photographic documentation will be the Egyptian sculpture seen by Duveyrier[12] in Ghadames.

On our way to the plateau of the Ahaggar we hope to identify the mysterious Mt. Gyri, the "Mountain of Precious Stones" of the ancients, and perhaps to find whence came the jewels found in the tombs at Carthage. The emeralds of the Garamantes were very famous in ancient Rome. Of great importance will be the discovery of elephant remains. Pliny states that many of these animals were brought from the banks of the Guir, the identification of which has been much discussed, as well as north of the "lakes" of Mihero in the Ahaggar. The water holes of the Wad Mihero, a branch of the Igharghar system, still contain crocodiles.[13] We shall pass the river Igharghar, the great wadi leading northward from the Ahaggar.

The Ahaggar itself is the highest platform of the great massif of the Tuareg Sahara. The Atakor, as it is called, which has a greatest diameter of 250 kilometers, has an elevation of over 2000 meters, and on it the denuded volcanic peaks rise to almost 3000 meters. We hope to scale the culminating point, Mt. Ilaman. On this and other high peaks snow is to be seen at times—this in the heart of the Sahara. Northward the Ahaggar is prolonged by other massifs over 1000 meters in height—the Tassili, Muydir, and Ahnet—while still lower plateaus extending northward connect with the Atlas. To the south are the massifs of Adrar des Iforhas and the Aïr, connecting with the Sudan. Eventually we hope to continue our studies to the last-named massif, which has been identified as the Agisymba Regia of the Greek and Roman historians. Here we shall look for traces of the civilizations from the north in the hope of confirming our belief that in antiquity these people traded with the cities of the north African seaboard.

[11] For the situation of Jerma see the admirable route map from Tripoli to Murzuk in Henry Barth: Travels and Discoveries in North and Central Africa (5 vols., New York, 1857), Vol. 1, facing p. 85.

[12] Duveyrier, *op. cit.*, p. 250.

[13] Cf. Gautier, Le Sahara, p. 74.

THE DISTRIBUTION OF POPULATION IN THE AMAZON VALLEY*

By W. L. SCHURZ
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The Amazon Basin is one of the world's great deserts. An area of 2,000,000 square miles supports a population of less than one to the square mile. It is comparable with the Sahara. Paradoxically the Amazon is a region of great natural riches. The comparative exportation figures cited by M. Le Cointe in his book on the Brazilian Amazon are illuminating.[1] Per head of population exportation from the Brazilian Amazon is 459 francs, a figure only surpassed by the richest countries of the world: for the United States it is 134, for Brazil as a whole 99. Per unit of area (square kilometer), however, the coefficient for the Amazon is only 103, for Brazil 220, for the United States 910.

M. Le Cointe carries the paradox further in expressing the view that the greatest hindrance to Amazonian development lies in the very wealth of natural and easily exploitable products. The extractive industries, of which rubber is paramount, have absorbed the population at the expense of agriculture that makes for permanent settlement. On the other hand, it is the quest for the "black gold" that has led to the settlement of much of the basin. But we shall consider later this prime question of the effect of rubber on the distribution of population in the Amazon. First let us examine the facts of distribution so far as they are known.

POPULATION STATISTICS

The total population of the tropical part of the Amazon Basin, which covers an area of some 2,000,000 square miles, is probably between 1,500,000 and 1,600,000. Of these about 1,300,000 live in Brazil, divided according to the federal census of 1920 approximately as follows:

Pará	800,000 (estimated)
Amazonas	363,166
Matto Grosso	40,000 (estimated)
Acre territory	92,379
Total	1,295,545

The population of the state of Pará in 1920 was given at 983,507 and of Matto Grosso at 246,612. However, nearly 200,000 of the inhabitants of

*The data contained in this article were gathered during the progress of the Crude Rubber Survey carried on by a special commission of the United States Department of Commerce during the period from August, 1923, to May, 1924.

[1] Paul Le Cointe: L'Amazonie Brésilienne, 2 vols., Paris, 1922; reference in Vol. 1, pp. 283–285.

Pará live outside the Amazon Valley proper, and it is doubtful if the sparsely settled rubber-producing regions of Matto Grosso have a larger population than the figure given above.

In the state of Pará the six north-bank "municipios," or municipal districts, of Faro, Obidos, Alemquer, Almeirim, Monte Alegre, and Prainha (the two last also extend south of the river) had a population in 1920 of 76,320, of which over one-third were in the district of Obidos. The great majority of this population dwells in a belt within 50 miles of the Amazon, though the "municipios" in question extend north to the borders of the Guyanas. Of the southern rivers of the state of Pará the zone of the Tapajóz had a population of 54,740, of which 41,546 lived in the important district of Santarém. The vast Xingú zone had only 14,815 inhabitants, of whom 9343 dwelt in the district of Altamira. It is an interesting fact that the heaviest concentration of population on the Xingú is above the first rapids, or *caxoeiras*, a circumstance largely accounted for by the flourishing *caucho* industry in the Iriry basin. Whereas Altamira is a place of much life and movement, Porto de Moz, located near the mouth and formerly a town of importance, is only a shell. On the other hand, conditions are reversed on the Tapajóz, where the upper river is of little importance as compared with the country bordering the lower river between Aveiro and Santarém. According to the census of 1920 the zone of the Tocantíns had a population of 71,679, of which Cametá accounted for 41,365. The four other municipal districts of Jurity, Portel, Bagre, and Oeiras, located on the Amazon but outside the zone of the three great rivers above named, had a total population of 28,675. Thus, that part of the state of Pará which lies between the Mojú-Tocantíns watershed and the boundary of the state of Amazonas had a total population of some 157,620 people. By far the larger part of this population is concentrated within a strip about two miles wide on each side of the main rivers and their tributaries.

The large island of Marajó, which lies athwart the mouth of the Amazon, had a total population of about 120,000, or about seven to the square mile. That part of the state of Pará below Gurupá on the Amazon and including the islands of the delta, eleven municipal districts on the south mainland within the drainage area of the Rio Pará mouth, and the north mainland districts of Mazagão and Macapá, had 560,775 inhabitants, or considerably more than half the population of the entire state.

The upper basins of the three rivers Tocantíns, Xingú, and Tapajóz, lying within the state of Matto Grosso, have a population estimated at not much over 10,000, most of whom are wild Indians. This, however, includes a great block of unknown country between the Tapajóz and the Xingú. Population estimates of such regions are extremely hazardous. Conditions along the known streams whose native peoples have often been reduced—by disease, war, or flight—give no clue to conditions in the interior. Farabee speaks of the Mundurucus driven from the banks

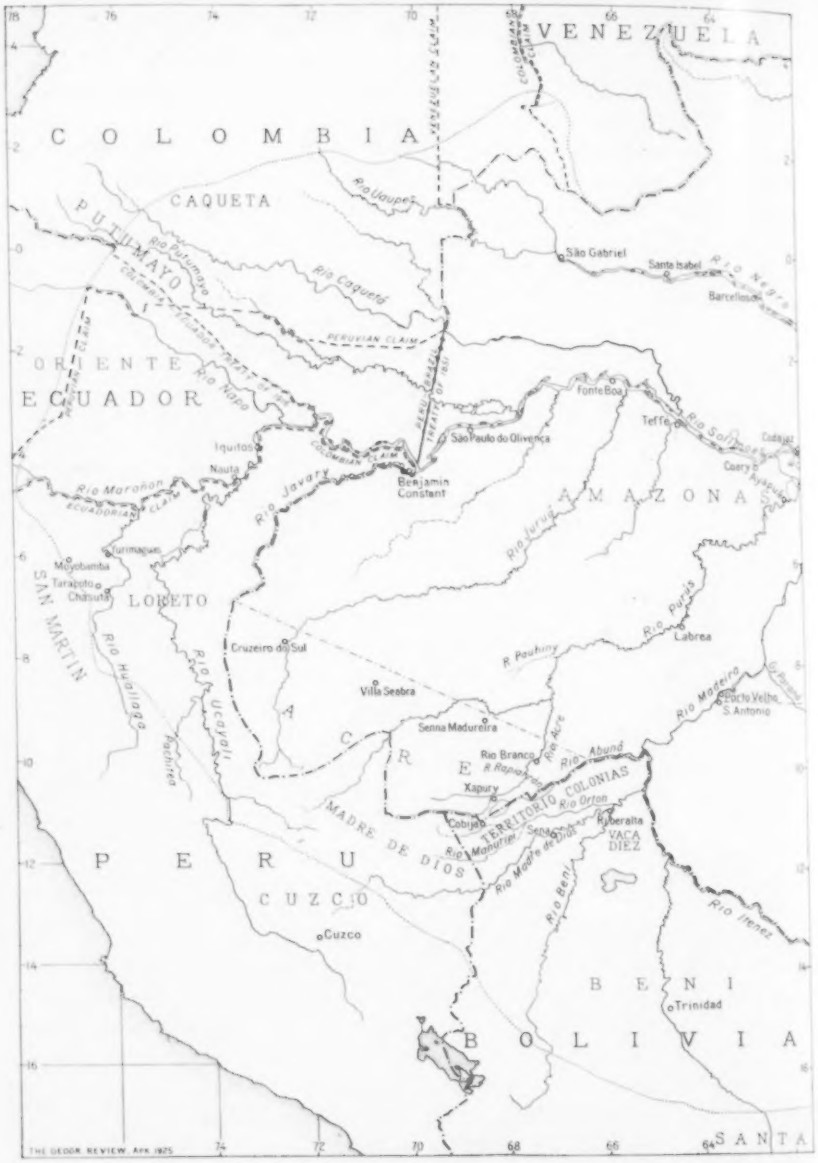
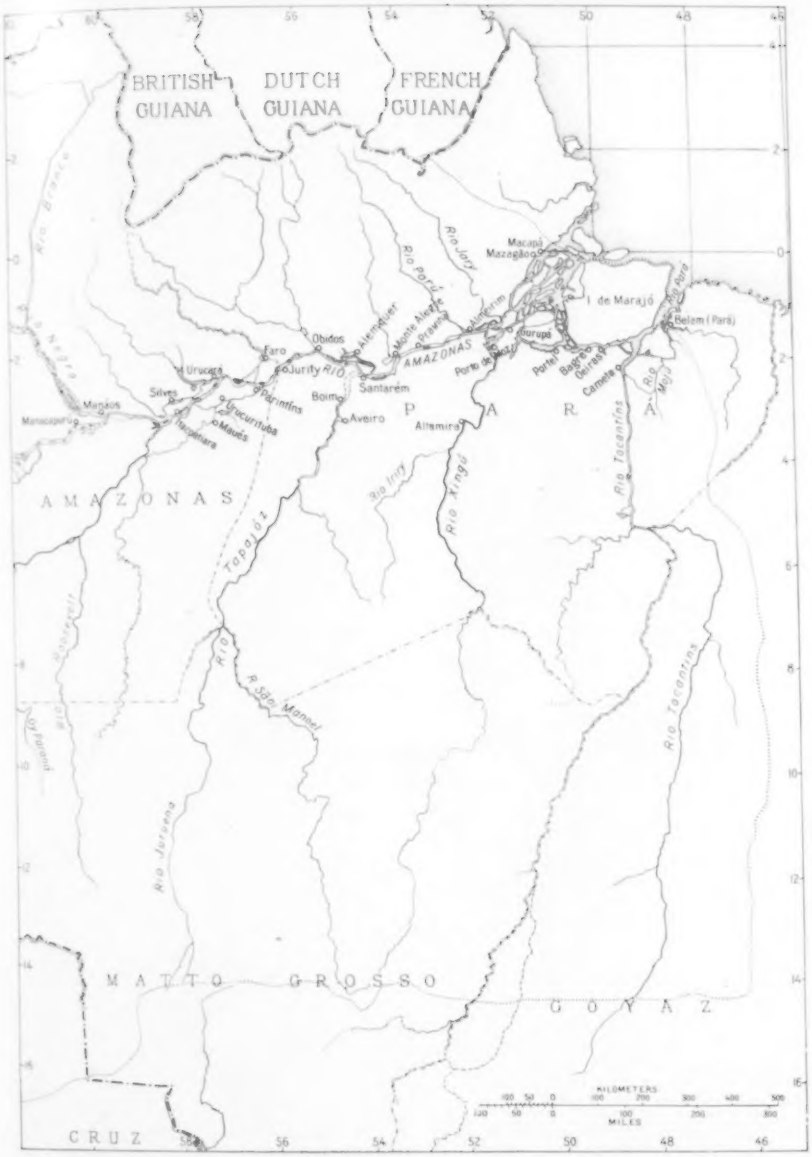


FIG. 1—Map of the Amazon Basin showing localities mentioned in the text. Western half. Scale approximately 1:15,000,000.



Eastern half. The dotted line represents the approximate limits of the tropical part of the basin.

FIG. 2—Remate de Males (Benjamin Constant), on the right (Brazilian) bank of the Rio Javary.

of the Tapajóz occupying the country from that stream eastward to the divide with the Xingú.[2] Colonel Fawcett reported "large populations of savages" in the forest sanctuary.[3] The enormous district of Santo Antonio do Rio Madeira was estimated by the federal census authorities in 1920 to have a population of only 18,000. At that time an area of probably 250,000 square miles tributary to the Madeira and including, in addition to the district above named, a wide belt of the state of Amazonas on both sides of the main river, had less than 75,000 inhabitants, or about one person to four square miles. All but a small minority of these live in close proximity to the Madeira or to the lower courses of its tributaries.

Of the 363,166 inhabitants of the vast state of Amazonas 75,704 dwelt in the municipal district of Manáos. Above Manáos the zone of the Rio Negro had in 1920 only 20,408, and that of its principal tributary, the Branco, another 7424. However, the population of the latter zone has increased considerably during the past few years. The two districts of Codajaz and Manacapurú on the Solimões had a total population of 24,314. The country which borders the Solimões on its left bank above the vicinity of Codajaz is extremely lightly populated. In fact, most of the region to the north of the upper Amazon is an absolute wilderness, and much of it is still unexplored, inhabited by small tribes of Indians who still live in the Stone Age. The only parts of this area that show any appreciable signs of development at all are Manáos and its immediate vicinity, the upper Rio Branco, which is the center of the balata and live-stock industry of the state, and the country along the north bank of the Solimões from the mouth of the Negro to the neighborhood of Codajaz. The rest of it, so far as it is inhabited at all, is populated by isolated groups of rubber or Brazil-nut gatherers or by turtle or *pirarucú* fishermen. The upper Rio Negro country, which a century ago was a center of considerable activity, is now in a state of complete decadence. The towns, such as Barcellos, Santa Isabel, and São Gabriel, are miserable villages, without any im-

[2] W. C. Farabee: The Amazon Expedition, [*Univ. of Pennsylvania*] *Museum Journ.*, Vol. 8, 1917, pp. 126–144; reference on pp. 128–129.

[3] P. H. Fawcett: Bolivian Exploration, 1913–1914, *Geogr. Journ.*, Vol. 45, 1915, pp. 219–228.

FIG. 3—Remate de Males, upstream section. This forms a panorama with Figure 2.

portance beyond the little trading that still gives them a certain excuse for existence. Though Manacapurú and Codajaz are places of only a few hundred inhabitants, they have potential elements of greater vitality than the moribund settlements on the Rio Negro.

It is probable that the population of the corresponding region to the south of the upper Amazon and lying within the state of Amazonas is between 100,000 and 110,000, or about one person to three square miles. Of these about 40,000 live in the basin of the Purús, and some 25,000 in that of the Juruá. The remainder are distributed between the five districts of Benjamin Constant, São Paulo de Olivença, Fonte Boa, Teffé, and Coary. On account of the great decline of the rubber industry in this territory the process of depopulation has gone even further than in the zone of the Madeira and on the lower Purús and Juruá has assumed the proportions of a veritable exodus. Only a comparatively small minority is still engaged in working rubber, many others having turned for a living to gathering castanha (Brazil) nuts or to fishing. However, the great majority have left the region which, with the exception of certain localities, particularly the Ayapuá castanha zone and the lands bordering the Acre territory, is in a state of frank decadence. Teffé is the only town of the region that presents any signs of vitality.

The triangle which lies between the lower Madeira and the lower Amazon, comprising the three districts of Maués, Urucurituba, and Parintíns, had a population of 32,087 in 1920. A corresponding area on the north bank, including the districts of Itacoatiara, Urucará, and Silves, had 24,910 inhabitants.

According to the census of 1920 the population of the Acre territory was 92,379, divided as follows among the different administrative units: Cruzeiro do Sul, 15,490; Rio Branco, 19,930; Senna Madureira, 21,141; Villa Seabra, 20,421; Xapury, 15,397. These districts correspond to the five principal towns of the territory and their tributary country. Of the five Seabra and Cruzeiro do Sul are in the basin of the Juruá, and the other three in that of the Purús. The population was 1.6 per square mile.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Santarém, at the mouth of the Tapajóz, one of the most flourishing towns of the Amazon Valley.
FIG. 5—Monte Alegre, on the left bank of the Amazon, State of Pará. Part of the town is built on the water front; part on bordering heights (see Fig. 16).
FIG. 6—Floods on the Tapajóz.

FIG. 7

FIG. 8

FIG. 9

FIG. 7—Serury, on the Rio Purús, one of the richest rubber-producing regions of the Amazon.

FIG. 8—Porto Velho, the downstream terminus of the Madeira-Mamoré Railroad, built to avoid the 200-mile stretch of rapids.

FIG. 9—Rio Branco (the former Bolivian village of Empreza), the capital of the Federal Territory of the Acre.

This rate is over three times that of the state of Amazonas and nearly four times that of Matto Grosso. Nearly all the rural population is engaged more or less directly in the rubber industry or is at least dependent on it for livelihood.

Only a general estimate can be made of the total population of the montaña regions of Peru, Ecuador, and Colombia, that is of the parts of those countries lying within the tropics of the Amazon Basin. Boundaries are either vague or are matters of active controversy, and up-to-date and reliable census records are nonexistent, so that the only basis for estimating the population is the scant local data available. Moreover, in the present state of development anything approaching a scientific census is out of the question. The Peruvian Department of Loreto, which is the most important administrative unit in the region under discussion, was estimated by the Geographical Society of Lima in 1896 to have a population of 100,596. At that time the Department of Loreto contained the two provinces of Moyobamba and San Martín, which have since been detached to form the new Department of San Martín. In 1896 the two provinces in question had an estimated population of 59,187, leaving a total of 41,409 for the rest of the department. Since that time only arbitrary personal estimates have been made. The average of such estimates as are within the realm of probability is about 60,000 for the entire department, exclusive of uncivilized Indians, whose numbers are variously given at from 60,000 to 100,000. These estimates include the population of the territory disputed between Peru, Ecuador, and Colombia, whose extent is ill-defined.[4] Most of the white and mixed population is concentrated in a narrow belt along the Amazon-Marañon, as far as the mouth of the Huallaga, along the Huallaga from its mouth to the vicinity of Chasuta, and in the zone bordering the Ucayali. The Tarapoto and Moyobamba districts of the Department of San Martín are also relatively well populated. The Indian population is heaviest in the country to the north of the main river.

To the south there are probably about 25,000 in those parts of the Departments of Cuzco and Madre de Dios in which rubber is found.

The latest Ecuadorian statistics give the population of the Province of Oriente at 100,000. The most recent Colombian figures put the population of the "Commissaries" of Caquetá, Putumayo, and Uaupés at respectively 74,254, 40,770, and 5500; but these statistics are undoubtedly greatly in excess of the actual population of those sparsely settled regions.

It may be very roughly estimated that the total population of those sections of the three countries in which rubber is found or is capable of being grown is between 200,000 and 250,000. This excludes the non-Amazonian parts of those countries, where tropical conditions prevail, as in the coast districts of Ecuador.

[4] Cf. R. R. Platt: Present Status of International Boundaries in South America, *Geogr. Rev.*, Vol. 14, 1924, pp. 622–638.

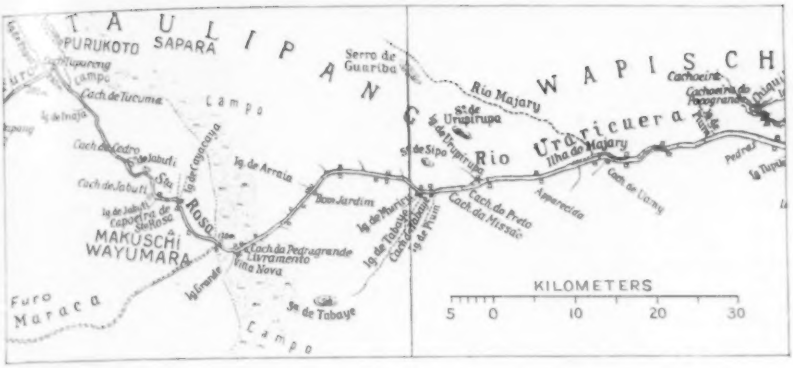


FIG. 10

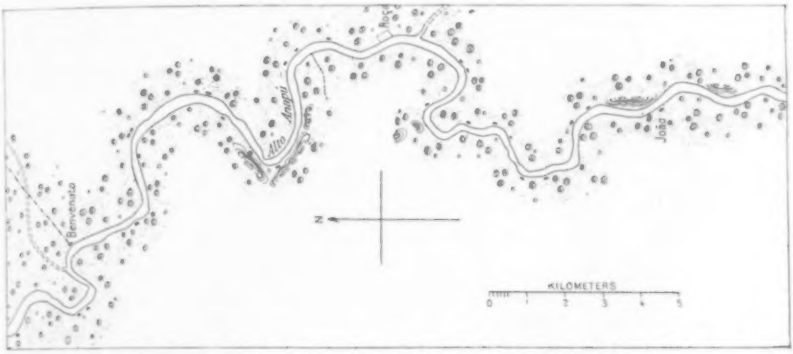


FIG. 11

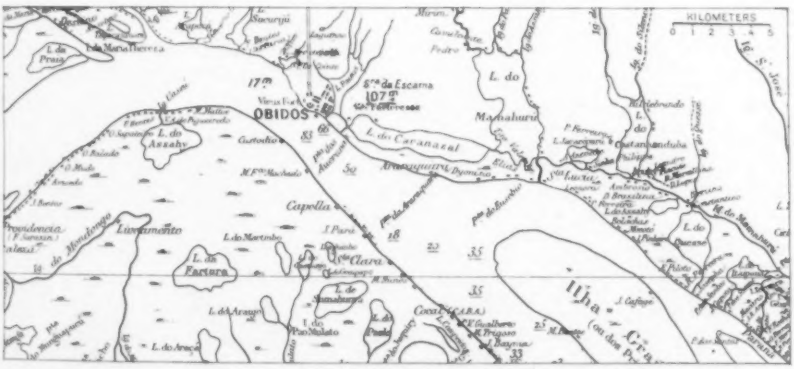


FIG. 12

FIGS. 10–12—Characteristic riverine settlement in the Amazon Basin. Compare the type figure on p. 69 of Brandt's "Kulturgeographie von Brasilien" (Stuttgart, 1922).

Figure 10 is from the route map in Koch-Grünberg's "Vom Roriama zum Orinoco, Vol. 1, 1917. It shows a portion of the Rio Uraricuera. The small squares indicate white, the triangles, Indian, settlements.

Figure 11 is a part of the Rio Anapú from H. Coudreau's "Voyage entre Tocantins et Xingú," 1899.

Figure 12 shows the Amazon about Obidos from P. Le Cointe's "Carte du Bas Amazone de Santarém à Parintins," 1911.

It would appear probable that the population of the tropical part of Bolivia in which rubber is native or where its cultivation is practicable is about 100,000. According to the official census returns of 1900 the population of the Territory of Colonias was 6883. At the same time the Department of El Beni was credited with having 25,119 inhabitants, and Santa Cruz with 151,062. In 1918 an official estimate gave the following figures: Colonias, 49,761; El Beni, 50,265; Santa Cruz, 327,382. However, estimates of such scattered populations as those of Colonias and the Beni can only be more or less distant approximations to the truth. An estimate prepared for the American Rubber Commission by a special committee of prominent citizens of Riberalta calculated the population of Colonias at 20,000 and of the Beni at 30,000, including 5000 in the province of Vaca Diez. These figures, from casual observation, would appear reasonably accurate. Captain Felipe Rivera, the army officer in charge of the topographical survey of the territory, and who had unusual opportunities for observation, estimates the population of the important sector between the Manuripi-Orton-Beni and the Acre-Rapiarrán-Abuná at from 8000 to 10,000. This estimate corresponds to the years 1918–1920, which were spent in that region. The distribution of this population by nationalities of origin was approximately as follows: Bolivians, 25 per cent; Brazilians, 35 per cent; Peruvians, 10 per cent; Syrians, 8 per cent; Europeans, 5 per cent; Japanese, 2 per cent; miscellaneous, 15 per cent.

Of the cities of Amazonia, Pará, the largest, has an urban population of about 180,000. The municipal district of Belem, in which the city is located, had a population in 1920 of 236,402. Manáos, capital of the state of Amazonas and commercial metropolis of the upper Amazon country, has some 40,000. Its municipal district was credited by the census of 1920 with 75,704 inhabitants. Iquitos in Peru probably has between 8000 and 9000. Santarém, located at the mouth of the Tapajóz, has about 5000 or 6000, somewhat more than the population of Cametá on the lower Tocantíns, and Obidos has in the neighborhood of 3000. The other more important places, such as Riberalta and Cobija in Bolivia, Yurimaguas in Peru, Porto Velho on the Madeira, Teffé and Itacoatiara on the Amazon, Altamira on the Xingú, and Rio Branco and Cruzeiro do Sul in the Acre, have populations ranging from 1000 to 2000, though Riberalta probably has more. Few towns give evidence of any vitality, and the majority are in frank decay. Among places from which life has departed are Nauta in Peru, São Paulo de Olivença on the upper Amazon, Labrea on the Purús, and Gurupá on the lower Amazon.

Racial Composition of the Population

The great mass of the population of Brazilian Amazonia is of mixed blood, the product of various degrees of mixture of the original Portuguese settlers with the native Indians and the descendants of negro slaves. The

rural population is commonly known by the term "caboclo," though different names may be applied to the various classes of mixtures, as "tapuyo" for the crossbreed of white and Indian. Among the native population of the states of Pará and Amazonas the Indian element predominates over the negro in the admixture, though both elements may be encountered everywhere in greater or less degree. In Matto Grosso the negro is an entirely negligible factor in miscegenation. The Cearenses, or immigrants from the state of Ceará, who constitute an especially important element in the Acre territory, are a mestizo people, that state not having been the

FIG. 13

FIG. 14

FIG. 13—The Bolivian town of Riberalta occupies a favored site on a bluff at the junction of the Beni and the Madre de Dios.

FIG. 14—Itamaraty on the Abuná.

seat of industries dependent on negro slave labor. However, the immigrants from the states of Maranhão and Piauhy, who also constitute a numerous section of the population in some districts, have a considerable admixture of negro blood. This is true of a large part of the population in the zone about the city of Pará.

The pure Indian is of steadily decreasing importance in the racial make-up of the Amazonian population. The more amenable tribes tend to lose their identity through miscegenation or other peaceful processes. Thus, many tribes like the Maués of the state of Amazonas and the Huitotos of the Putumayo country, are now classed as "mansos," or civilized. The less pacific or more helpless peoples are gradually being exterminated by intertribal strife or in clashes with the rubber gatherers, and disease has also taken a heavy toll among some of these folk. During the time of the great rubber boom the Indians were often relentlessly hunted, either as labor material or as irreconcilable opponents of the invaders of their tribal

lands. This occurred on a large scale in the valley of the Javary, in the Acre country, and in the Itenez basin in Bolivia, where the population is said to have been decimated in the search for laborers for the *gomales* or rubber forests of the Beni. Important peoples, like the Caripunas of the Madeira, have been greatly reduced in numbers and no longer appear on the rivers, as they were formerly wont to do. The process of extinction has been at least retarded by the work of the famous Rondon Commission in Matto Grosso, which has brought such numerous tribes as the Nhambiquaras under its supervision. Other agencies, governmental and religious, are working to the same end. Among these may be mentioned the post of the federal Indian Protection Service in the Pauhiny section of the Purús basin and the Benedictine mission stations in the upper Tapajóz country.

Scattered tribes of savage Indians still exist in spite of all the conditions operating against their survival. Among such are the robust Parintintíns of the great wilderness to the west of the Madeira, the Assurinís of the right bank forests above the "Great Bend" of the Xingú, the Huambizos and Aguarunas of the upper Marañon lands in Peru, and the Cashipos of the Pachitea valley in the basin of the Ucayali.

Very few of the class of rural laborers are white. The whites are largely restricted to the large towns and to the class of landed proprietors. There are a considerable number of Portuguese, engaged in business and in the trades, and there are small Italian colonies in the larger cities. An American colony, founded near Santarém by immigrants from the southern states during the Reconstruction Period, now consists of only a few scattered families, of which the second generation has been well Brazilianized. Two recent attempts at the colonization of parts of the Ucayali basin in Peru by Americans have failed completely.

Though unimportant in the aggregate, the Syrians are a ubiquitous element in the Amazonian population. Popularly known as "Turks," they are found everywhere as traders, either established in the towns or traveling up and down the rivers as itinerant merchants. In some places, as at Rio Branco in the Acre, they almost monopolize the retail business, and at Pará they have a few very important commercial houses. Though frowned upon by the native business class, they manage to flourish and tend to form Brazilian families through intermarriage with women of the country.

There has never been any considerable immigration of Orientals into the Amazon Basin. Most of those who are found there came down into Bolivia from Peru by way of the Madre de Dios. The Suarez rubber properties have employed as many as 300 to 350 at one time, and other landowners have also used them. However, most of these Japanese abandoned the rubber forests because of the decreased remuneration offered by the proprietors. Many have settled in the towns, including about 300 in Riberalta and a large colony in Trinidad, where for the most part they have either monopolized the local business of small shopkeeping or work

FIG. 15

FIG. 16

FIG. 15—S. Paulo de Olivença, on the right bank of the Solimões.

FIG. 16—Monte Alegre. Part of the town is built on the slopes of a sandy plateau rising some 70 kilometers above the river (compare Fig. 5).

as truck gardeners, barbers, tailors, and at other trades. They generally form native households that are prolific in sturdy children. The number of Chinese in Bolivia is insignificant, but in Peru they constitute a very important class of retail traders.

Factors Affecting the Distribution of Population

Proximity to a navigable river is one of the principal factors determining the distribution of population in the Amazon Valley. There, in lieu

Fig. 17—Manacapurú on the Solimões, a short distance above Manáos.

of trunk roads and railways, rivers are the main arteries of communication, and settlement centers on their banks for facility of transportation, as well as for the feeling of connection with the outside world that comes from the more or less frequent calls of steamers. Moreover, the rivers are fruitful sources of food, either of turtle meat or of the *pirarucú* or other fish.

The Amazon and its important tributaries have regular lines of steamers that ply to their limits of navigation. This point is usually determined by the first rapids; but where rapids are absent, as in the Purús or the Juruá, the limit of navigation is pushed much farther up the rivers during the rainy season. The Purús, for example, rises from 40 to 50 feet between December and March, so that remote points on the upper reaches of its system are then accessible directly from the Amazon. Places that can then be reached in a few days may be weeks distant by canoe from navigable water during the dry season. The remote rubber fields of the upper Acre, of the Gy-Paraná or Machado above its *caxoeiras*, or of the São

Manoel in Matto Grosso are representative examples of the long isolation of the dry months.

The sites chosen for settlement are generally on *terra firme*, or high land, well above the flood level of the rivers. Among the few towns subject to frequent flood are Trinidad in the Mojos Plains of the Beni and Benjamin Constant (Remate de Males) on the Javary. Some, like São Paulo de Olivença and Fonte Boa on the Solimões and Riberalta on the Beni, are situated on especially high ground. San Pablo and Sena, two important establishments on the Madre de Dios, are situated about 300 feet above

FIG. 18—A house on the road to Tres Casas, Rio Madeira.

the river. On rivers like the Purús settlements are generally located on *barrancas*, or bluffs, where the great bends of the river skirt the edge of the *terra firme* on either side, as the stream meanders across its wide flood plain. Where houses are located on so-called *varzea* land, that is ground subject to inundation, they are often raised on a platform so that the floor is above the level of all but extraordinary floods. However, such exceptional deluges as have lately ravaged the banks of the lower Amazon over a number of years upset all calculations founded on years of security and struck a serious blow to long established agricultural communities, like those of the Paraná of Obidos.

Another reason for avoiding low ground as sites for settlement is the greater risk from malaria. The association of malaria with swampy or ill-drained land is now generally comprehended by the natives; but many of the old *barracões*, or establishments, on the Madeira and the Purús are located on land that is infested with mosquitoes. More often than not the mosquitoes are not of the Anopheles variety, but nevertheless they

constitute a burden to the life of the inhabitants. One settlement on the Madeira bears the significant name of Carapanátuba, the *lingua geral* for "many mosquitoes." Parts of the lower Ucayali basin and of the low Mojos prairies in Bolivia are rendered almost uninhabitable by mosquitoes. Epidemics of malaria in malignant form occasionally ravage the population of certain streams and lead to an exodus of the population to more healthful localities.

Another important factor in determining the course of population is an economic one—the opportunities offered for earning a living. Dependence on the extractive industries has tended to attract population always farther into the interior, particularly when prices of the products sought have been high enough to justify the extra effort required in opening up new and more fruitful areas. In the introduction to this paper reference was made to the importance of the quest for rubber as a motive force in the settlement of the Amazon Valley. Certainly this was true before the collapse of the great rubber boom after 1910. For about two decades previous to that there had been a fairly steady movement of population up the southern tributaries of the Amazon in search of new stands of the coveted *Hevea brasiliensis*. There were also movements of a similar character down the remote upper rivers from the side of Bolivia and Peru. Bolivians flocked into the Beni basin from the Santa Cruz country or from the valleys of the sierra, and Peruvians occupied the lands between the Huallaga and the Javary, crossed the Amazon into the Putumayo valley, and penetrated across territory disputed with Colombia to the distant Caquetá.

Interesting references to the movements of the rubber gatherers in Matto Grosso are given in the reports of the Rondon Commission. On the Rio Roosevelt the *seringueiros* coming upstream had penetrated as far as latitude 10° 24′ S. by 1914; on the Juruena to 8° 20′; on the Telles Pires (1915) to about 9°. The commission further notes the existence of a "no man's land," 300 to 500 kilometers broad, separating the rubber gatherers of the northern part of the state dependent on Manáos and Pará from a belt in the center of the state dependent on the city of Matto Grosso.[5]

One of the most interesting types in the Amazon Valley is the Peruvian *cauchero*. While this class includes large numbers of Brazilians, the Peruvian *cauchero* has a special fame throughout Amazonia. These men are workers of the class of rubber known as *caucho*, the product of the *Castilla elastica*. In contrast to the process of tapping the *Hevea*, whose exploitation constitutes a more or less settled industry, the working of *caucho* demands a nomadic life. This is due to the fact that the trees are cut down in order to extract the latex, forcing the *caucheros* to keep up an endless search for new stands of the *Castilla* tree.

[5] For a summary see Pierre Denis: Résultats géographiques des explorations du colonel Rondon au Matto Grosso, *Ann. de Géogr.*, Vol. 33, 1924, pp. 46–65.

Brazilians worked far up every river from the Tocantíns west to the boundaries of Peru and even searched the forests of the northern rivers for "weaker" grades of rubber, the *Hevea brasiliensis* being confined to the south of the Amazon, save for a small zone on the left bank of the Solimões. The outstanding episode of this great movement was the occupation of the Acre, then under the rather vaguely asserted sovereignty of Bolivia. Settlers from Brazil, chiefly Cearenses, ascended the Purús or

FIG. 19—Cattle on the campos of the upper Rio Branco, the southern extension of the great grasslands of the Orinoco basin.

the Juruá, took possession of the lands along the upper rivers, and carried out a separatist movement similar to that which led to the annexation of Texas by the United States. The Acre, the classical rubber land, thus became by the Treaty of Petropolis in 1903 a federal territory of Brazil.

The Cearenses, who played so prominent a part in the settlement of the Acre, are an adventurous element, of great initiative, and given to roving when once detached from the native habitat of their inhospitable state. The periodic drought to which Ceará and the adjacent states of northeastern Brazil are subjected has been a powerful contributor to the population and exploitation of the Amazon. The first great influx of Cearenses to the region was a result of the terrible drought of 1877–1879. Every succeeding drought has been followed by an exodus from the affected territory. In 1916 according to M. Le Cointe[6] between 8000 and 10,000 Cearenses arrived on the Amazon, most of them destined for the *seringaïs* of the upper river. Even with the decline of rubber exploitation on the Amazon new workers have been needed, for the industry has proved exceedingly

[6] *Op. cit.*, Vol. I, p. 379.

wasteful of human life. Writing in 1913 Dr. Oswaldo Cruz said: "On the rivers Acre, Abuná, Kapury, and others, the destruction of human life attains exceptional proportions." Since then, however, conditions have greatly changed for the better. The Acre today may be considered one of the most healthful parts of the Amazon Valley.

The Cearenses are disposed to return to their native state when opportunity offers. However, many have identified themselves permanently with the localities which they have done so much to develop. Considerable numbers have penetrated into Bolivia from across the borders of the Acre and by way of the Abuná. In this connection I recall an incident that took place while crossing from Cobija on the Acre to the Suarez rubber post of Porvenir on the Tahuamanu. On observing some persons engaged in the preparation of manioc flour we inquired whether it was "yuca" or "mandioca," respectively the Bolivian and Brazilian words for manioc, and received the reply: "E mandioca, e somos cearenses."

After the sensational crisis that followed the high prices of 1910 there ensued an exodus from all the rubber districts. Men flocked down to Manáos and Pará by the thousands, and large numbers returned to drought-ridden Ceará and the other northeastern coast states. The same fate befell all the upper rivers, and some regions, such as the country above the rapids of the Tapajóz, were nearly depopulated. The rubber industry in Peru almost ceased to exist, its place being taken by the collection of gutta percha and tagua nuts and the cultivation of cotton in the Ucayali basin. There have been occasional recurrent movements into the Brazilian rubber districts, whenever prices have again reached a sufficiently remunerative level, but none of the movements have attained anything approaching the magnitude of the great exodus of 1912. Early in 1924 we saw one steamer laden with over 300 rubber workers from the Juruá, when the price of rubber was hovering around two milreis per kilo in Manáos and Pará.

In certain regions the gathering of castanha, or Brazil, nuts has superseded in importance the traditional rubber industry. This is largely in the nature of a seasonal occupation, the gatherers being recruited in other districts for a short period and returning to their homes after the crop is harvested. Owing to good prices this industry has flourished of late on the northern rivers from the lake country of Anajá and Codajaz in the zone of the Solimões east to the Parú and the Jary, and over a wide area to the south of the Amazon, culminating in the valley of the Tocantíns. Consequently there has been a large annual ebb and flow of population between the *castanhaes*, or Brazil-nut forests, and older settlements along the main rivers.

A similar movement has been the influx of laborers into the balata-yielding forests of the Rio Branco basin north of Manáos. However, the majority of these workers return to Manáos at the end of the tapping season, unlike the rubber workers, whose tendency is increasingly to remain

on the property throughout the year. This is in part due to the double circumstance that the working of balata has been so profitable that no one could be induced to devote his efforts to the production of foodstuffs in that region and that the comparatively large income made by the workers tempted them to go to Manáos to spend their *saldo*, or balance.

The ease with which land may be acquired also has an influence on the distribution of population. Much public land is still available in certain localities, but the more accessible lands have generally been occupied long since, as has occurred in the Acre. The various state governments are usually lenient with squatters on state lands, when the intention of serious settlement is evident, and tend to allow the validation of such rights, or "direitos de posse," as they are known in Brazilian law. The land laws of the three Brazilian states, as also of Bolivia and Peru, make generous provision for the acquisition of homestead properties.

Real settled communities exist only in a few localities. Among them are those which supply the cities of Pará and Manáos with such primary foodstuffs as corn, beans, and rice, the cultivators of *guaraná* (a shrub whose seeds are used in the preparation of a stimulating drink) in the Maués country, the cacao growers below Obidos and on the lower Tocantíns, the owners of small rubber plantations about Boim and Aramanahy on the lower Tapajóz, and the cotton growers of the Ucayali in Peru. Dependence on a local food supply has done much towards fixing the population in certain regions, as in the Acre, which has gone far towards self-sufficiency in this respect. The Acre now produces nearly everything that it eats, and as a result of this condition the inhabitants tend to remain on the land when the price of rubber makes its working less remunerative, rather than abandon the *seringal* for Manáos or Pará. The same tendency is noticeable in other localities, as in Bolivia and on the lower Purús. Under this new régime during the season when the tapping of the rubber trees is suspended or relaxed the *seringueiros* dedicate themselves to the cultivation of beans, corn, rice, manioc, bananas, and sugar cane. Fish are also caught and salted, and pigs and chickens are raised. This is contrary to the old system, whereby the proprietor discouraged the production of foodstuffs by his workers, because of the profit which he made on their sale and because he preferred that the *seringueiro* devote all his time to the production of rubber. A few proprietors have clung to the old system, but the majority have accepted the new conditions as more advantageous to all concerned.

THE JAMES BAY COASTAL PLAIN

NOTES ON A JOURNEY*

By E. M. KINDLE
Geological Survey, Canada

The wide, flat, horseshoe-shaped plain which borders James Bay has been known to the old French *coureurs de bois* and the *vogageurs* of the fur companies since 1662, when the two Frenchmen, Radisson and Groseilliers, reached James Bay via the Moose. But it still belongs to the domain of the fur trader and the Indian and remains as little known to the general public as the far Northwest. However, a railway to James Bay is now under construction by the Ontario government. When it is completed it will be but a day's journey from Ottawa to Moose Factory, Ontario's undeveloped northern seaport. The route which has been surveyed for the James Bay railway leaves the Canadian National line at Cochrane and follows the general direction of the Abitibi River, reaching tidewater at Moose Factory. Seventy miles of track have been laid on this line.

North of rail-end the canoe route is still the only road to the coastal plain and the sea. The journey is usually made by one of the three largest rivers of the region south of James Bay, the Abitibi, the Mattagami, and the Missinaibi. The first-named is the shortest and is generally preferred. Supplies for the trading posts at Moose Factory are frequently sent from the railway via the Pagwachewan and Albany River route which, though much longer than the Moose River routes, is without portages or rapids of consequence. All of the other canoe routes to the Bay involve numerous portages and the running of rapids which require skilled canoemen.

The Abitibi River was traversed by the writer on the north-bound trip to the Bay. A thirty-mile cruise was made up the James Bay shore before starting on the return journey, which followed the Missinaibi River and ended at Mattice, October 3, 1923. The nearest good harbor to Moose Factory is Charlton Island. Here supplies arriving by sea are transferred to schooners or other small craft capable of threading the channels about the mouth of Moose River. The difficulties of securing deep-water approaches to Moose Factory, if it should ever develop as a port, are comparable with those which have been overcome at the harbors of La Plata and Buenos Aires in the Argentine Republic, where the harbor approaches are for many miles through depths of from one to four fathoms.

A broad belt of relatively high land, known as the "clay belt" rims the southern border of the James Bay coastal plain. The topography of the clay belt through which the Canadian National railway runs closely approximates that of northern Ohio and the Ontario peninsula. The hilly preglacial

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surface has been deeply buried by glacial till, which shows a flat or slightly rolling surface 750 to 950 feet above sea level near the railway. The clay belt offers the most extensive area of good farming land for future colonization on the Laurentian Plateau. Since the construction of the railroad considerable agricultural development has already taken place there.[1]

North of Cochrane, in the clay belt, settlement and agricultural development have extended 13 or 14 miles. West of Cochrane, along the Canadian National line, settlement of the land has extended a much shorter distance from the railway. On Missinaibi River the untouched forest reaches to within a mile of the railway. A well-equipped Dominion experimental farm is located at Kapuskasing.

In the northern part of the belt, 30–60 miles north of the Canadian National railway, there is a strip of country where the rivers are characterized by numerous falls and rapids. The Abitibi River canyon and other localities on this river afford promising sites for water power. In crossing this belt to the coastal plain the grade of the Abitibi rises to 36 feet a mile for six and a half miles, while the grade north and south of it is respectively 3.4 and 5 feet a mile. The accelerated grade in the Abitibi River in the vicinity of the canyon is rather closely paralleled by that found in other branches of the Moose west of it.

The Topography of the Coastal Plain

The scarplike northern margin of the clay belt delimits the southern border of a very youthful plain that has emerged from the sea since the postglacial submergence. The slope of the plain is remarkably uniform, amounting to 3.4 feet a mile along the Abitibi and Moose Rivers. Its width is from 75 to 100 miles in the basin of the Moose River; it is still wider toward the northwest in the basin of the Albany River and continues to Cape Henrietta Maria and beyond. According to W. J. Wilson, "the country is as flat as it can be"[2] along the Kapiskau River, northwest of the Albany River, for 175 miles. On the eastern side of James Bay the coastal plain narrows toward the north and disappears. Near Cape Jones at the northeastern corner of the bay the plain gives way to high land, which rises near the shore from 1000 to 2000 feet above the sea[3] between Cape Dufferin and Cape Jones. The land is low on the eastern side of James Bay with a gentle slope as far north as East Main River, where the elevation 100 miles inland is only 700 feet.[4]

[1] Helge Nelson has clearly described the climatic and other factors controlling the agricultural development of the clay belt (Interior Colonization in Canada: *Geogr. Annaler*, Vol. 5, 1923, pp. 275–289, Stockholm). See note in this number of the *Review*.

[2] W. J. Wilson: Reconnaissance Surveys of Four Rivers Southwest of James Bay, *Canada Geol. Survey Summary Rept.*, Vol. 15, 1902–03, pp. 222A–243A; reference on p. 225A.

[3] Robert Bell: The Labrador Peninsula, *Scottish Geogr. Mag.*, Vol. 11, 1895, pp. 335–361; reference on p. 338.

[4] A. P. Low: Report on Explorations in the Labrador Peninsula, etc., *Canada Geol. Survey Summary Rept.*, Vol. 8, 1895, pp. 5L–387L; reference on p. 22L.

FIG. 1—Hudson Bay post at Moose Factory. The photograph shows islands in the estuary of the Moose River where the width is about 2½ miles. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

Fig. 1—Hudson Bay post at Moose Factory. The photograph [illegible] Fairchild Aerial Surveys Company [of Canada] Ltd.)

Fig. 2—View showing Fort Albany and heavily forested island back of it. The straight lines represent surveyors' lines cut through the forest. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

The seaward margin of the coastal plain is seldom well defined. Its location varies from day to day according to the height of the tide, which depends largely on the strength and direction of the wind. A north wind may

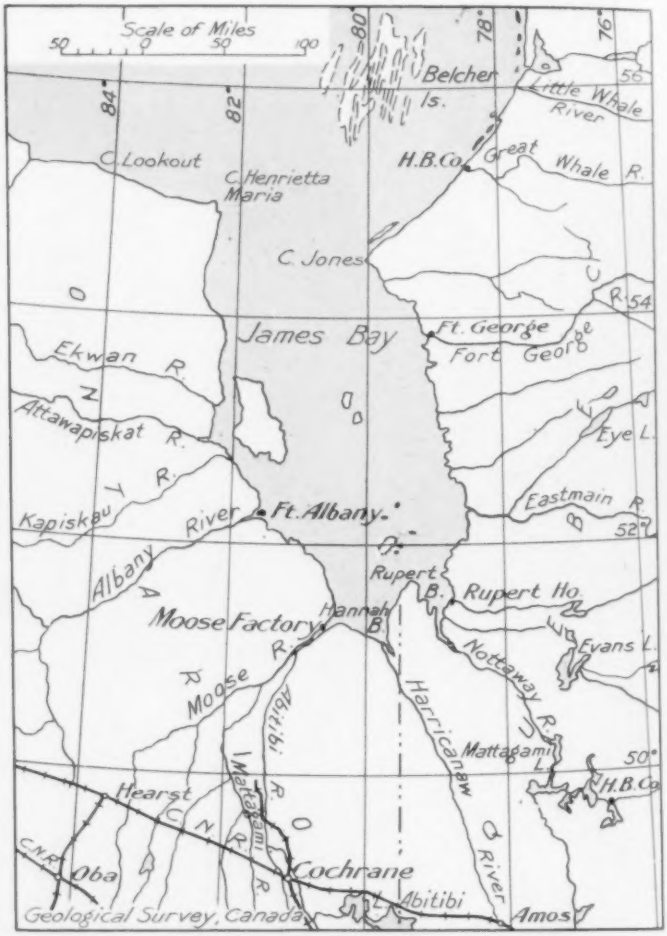

FIG. 3—Sketch map of the James Bay region. Scale approximately 1:6,500,000.

raise it nearly twice its normal height, and a south wind can reduce it in like degree. A strong wind from the sea may push the shore line inland a half mile or more from the position it occupied during a period of calm weather, while a breeze from the land may hold the flood tide far to seaward of its average position.

The coast line presents from the sea an intensely monotonous aspect. West of the Moose River it appears to trend away northwestward without

indentation. Bays ten or fifteen miles long and a mile wide make no appeal to the eye. The land is entirely without relief, and twelve miles from shore it becomes invisible. Traveling by canoe at high tide one gets the impression of voyaging over the surface of a huge saucer filled to the point of overflowing. No one familiar with this coast is likely to disagree materially

FIG. 4.—Islands in the Albany River near the sea margin of the coastal plain. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

with Magistrate Borron's estimate of its defects from the standpoint of the *voyageur*, which he stated thus:

> The shallowness of the water, the number of boulders, the dearth of harbours or shelter of any kind, the impossibility of either going ashore or embarking again without wading, sometimes long distances, the poorness of the camping grounds, and scarcity of both fuel and fresh water, are the cause not only of delay, but the source of constant anxiety and discomfort to the *voyageur*.[5]

The writer found an abundance of fuel in stranded logs and of fresh water; but this no doubt, was largely a matter of luck.

At low tide the sea retreats from two to six miles or more from the high-tide shore line. The broad intertidal zone which is thus laid bare at low tide appears to the eye quite flat. It is floored generally by rather firm, well rippled, sandy silt or clay which is plentifully sprinkled with glacial boulders. An occasional *Fucus* attached to a pebble is seen on this intertidal bottom.

[5] E. B. Borron: Reports of the Stipendiary Magistrates with Respect to the Northerly and Westerly Parts of the Province of Ontario, Legislative Assembly, Ontario, 1882, p. 43.

A fine green grasslike plant one to one and a half inches high covers much of the intertidal bottom at many localities and extends over the regularly submerged zone often several hundred yards from shore. Mussels and two or three other shells are common and widely distributed over this zone.

Along the landward margin of the wide intertidal belt runs a neutral zone debated between land and sea. Pools of salt or brackish water only a few inches deep and from 2 to 60 yards in diameter occupy most of this area. About a quarter of these panlike basins have forming on their bottoms a slimy black mud which is associated with green salt-water algae and may be a by-product of its metabolism. Landward this salt-pond zone passes into a belt where the high tides only rarely reach, and here the dry bottoms of the shallow panlike depressions are beautifully mud-cracked.

The salt-pond zone with its very sparse halophytic vegetation merges into a zone slightly higher where the ponds are scarce or absent and the surface is clothed with a dense growth of marsh grass often making natural hay land. This zone is capable of furnishing an abundance of wild hay. Cattle kept at Moose Factory are supplied with hay from this source. Marshy spots in this zone support colonies of cat-tails and other fresh-water plants, and fresh-water molluscs are very abundant in some of the small shallow fresh-water basins in this zone. Patches of dead cat-tail, the absence of trees, and occasional pieces of driftwood point toward marine invasions at rather widely spaced intervals.

The forest zone is separated from the prairie zone by a belt of straggling willows. The willow zone with other shrublike trees forms the outer border of the spruce forest which everywhere lies a short distance back of the prairie zone.

Glacial boulders, which have doubtless been dropped by stranded ice, are much more abundant on the normal intertidal zone than on the brackish pond zone adjacent to it, thus suggesting a longer period of sea-level stability at its present position than it experienced when the zones now inside the intertidal zone were submerged. Patches of clay and stones left by stranded ice are occasionally seen on the salt-pond zone.

The featureless character of the coast continues on beyond the Albany River, as the following description relating to the mouth of Chikeney Creek will indicate:

> At that point, the woods are about three miles back from the average high-tide mark. Between the forest and the tide mark is an open, level plain, the first mile of which is covered with scrubby willows. The other two miles support a growth of luxuriant grass. This grass gradually gets thinner as it approaches the water until at last only scattered bunches of it remain. Between the extremes of high and low tide a space of about three miles of soft clay mud intervenes; this is also perfectly flat and covered with small boulders. On the mud when the tide is out lie shallow pools of salt water. From the last bunches of grass it is hardly possible at low tide to see the open water.[6]

[6] A. R. M. Lower: A Report on the Fish and Fisheries of the West Coast of James Bay, in "Repts. on Fisheries Investigations in Hudson and James Bays and Tributary Waters in 1914," Dept. Naval Service for year 1914, p. 39.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—The tide pool or sea margin zone of the coastal plain.
FIG. 6—The prairie zone just inside the zone of mud-cracked tide pools.
FIG. 7—The spruce forest zone which lies on the inland side of the willow zone inland.

The sounding line has shown that nearly the same monotonous seaward slope that characterizes the land continues under the sea as far as the middle of James Bay. The sea-bottom grade from shore toward the middle of James Bay runs generally between two and three feet a mile. There are few coast lines where the sea-bottom grade is so low. Most of the coast of Holland, which is noted for shoal water, has a steeper seaward grade than James Bay; but the stretch of sea bottom west of the Zuider Zee, known as the "Broad Fourteens" is comparable with the southern part of James Bay in depth and grade. It recalls also the Rio de la Plata embayment on the South American coast, where the depth over an extensive area rarely exceeds ten fathoms.

The general uniform flatness of the James Bay sea bottom is broken by bars and well defined channels around the mouth of the Moose. The uniformity of bottom also fails between the large island of Akimiski and the mainland. The four daily high tides characterizing this channel produce strong currents, which trench a part of it to a maximum depth of 18 fathoms.[7] The splitting of tidal currents in James Bay responsible for the "Cock" and probably other gravel bars on the coast is shown in Lower's diagrammatic chart.[8]

The Albany River shortly before it enters the bay wanders among a maze of islands, as shown in Figure 4. The deep trenchlike cutting through the heavily forested island in the left foreground which may have developed during an ice jam, probably represents a preliminary stage in the slicing of this island into two parts. Such trenches are not uncommon in the islands of northern rivers composed of alluvial or other unconsolidated beds.

The lower 18 miles of the Moose River has a width of from three to three and a half miles where it spreads among numerous islands. It narrows to half that width at a distance of 25 miles from the coast. The appearance of the river near its maximum width as seen from the air at Moose Factory is shown in the photograph, Figure 1. The banks of the Moose, which stand at high tide only a few inches above the water at the mouth of the river opposite Shipsand Island, rise to 18 or 20 feet above high tide eight miles up stream. Along the Missinaibi branch, ten miles above its junction with the Mattagami, the bank stands 30 to 45 feet above the river. Near the southern margin of the coastal plain the streams are incised still more deeply. At the junction of the Wabiskagami the stream is cut 100 feet or more into the level plain.

The coastal-plain channels of the rivers show a somewhat definite correlation between height of bank and width of stream where the materials are of uniform character, like the glacial drift or marine clay. Along a stretch of the Missinaibi where the height of bank changes from about 50 to 100 feet the width of the river, within the higher banks, is reduced by about

[7] Lower, *op. cit.*, p. 42.
[8] *Ibid.*, p. 67.

half. The grade of these rivers is too high to permit much swing or meander development, and they tend to keep fairly direct channels.

Climatic Conditions in the James Bay Region

The summer and fall temperature of the coastal plain would appear to be somewhat more favorable than is commonly imagined. The average temperature at Moose Factory for the summer months is very close to that recorded for Calgary, Alberta. The ten-year mean of the two localities for August is identical, and for June, July, and October it differs by only one degree. These two widely separated points in nearly the same latitude show greater contrasts in winter temperatures, as the following table indicates:

Table I—Mean Temperatures at Cochrane, Moose Factory, and Calgary[9]

Month	Cochrane Lat. 49° N.	Moose Factory Lat. 51°15′ N.	Calgary Lat. 51° N.
January	0	−3	11
February	1	−2	14
March	16	11	25
April	33	28	40
May	46	42	49
June	58	55	56
July	64	62	61
August	59	59	59
September	51	52	50
October	39	40	41
November	24	24	26
December	8	5	20
Annual means	33	31	38

A temperature record kept during the trip to James Bay compared with Weather Bureau figures for Cochrane showed higher records for the points on the coastal plain. These figures appear to substantiate the opinion that the decrease in elevation in proceeding from the Height of Land and the clay belt to James Bay and proximity to that body of water more than compensates for the higher latitude in temperature control.

On the 12th, 13th, and 14th of September, 1923, a light snowfall occurred along the line of the Canadian National railway. At Kapuskasing nine inches of snow fell. In the Lake Superior district traces of snow were reported on the same dates over a distance of 676 miles along the Canadian Pacific railroad. A trace of snow was also reported from Ruel, located in the

[9] Frederic Stupart: Ann. Rept. Meteorol. Service, Canada, 1921. The record represents mean temperatures for a ten-year period. See also isotherm charts in Frederic Stupart: Climate and Meteorology, *Canada Year Book*, 1920, p. 164.

intermediate region between the two railways, and from some points east of Georgian Bay.[10] The failure of this widespread snowfall to extend north into the James Bay coastal plain is noteworthy in this connection. The temperature record kept during the journey shows, moreover, that there was no approach to snowfall conditions in the vicinity of James Bay.

The highest temperature in the coastal plain recorded on the trip was on September 26, when the noon and afternoon (between 5 and 8 P. M.) readings were 72° and 64° respectively. An exceptionally fine display of the aurora borealis was observed on the evening of this day, which is noted here because of the unusual temperature conditions associated with it.

Mr. Ward, agent of Revillon Frères at Moose Factory, states that he has observed a temperature of 99° inside his office, which has a southern exposure. The transient visitor, however, finds a good index of the coastal-plain climate in the luxuriant gardens kept by the Post managers and the Mission at Moose Factory. These show that all of the vegetables, including tomatoes, except corn and certain other heat-loving plants commonly grown in the Ottawa valley, do well in the Moose River valley except in the occasional seasons when summer frosts occur.

A number of late-blooming plants were seen in blossom throughout the latter half of September on the coastal plain. Five plants [11] in full bloom collected at Tom King rapids, Missinaibi River, on October 1 indicate that winter does not follow summer so precipitately in the James Bay region as is often supposed by dwellers in the south. More delightful weather than that encountered during the latter half of September on the coastal plain would be hard to find. The mosquito and black fly both disappear early in September, enabling one in early autumn to enjoy fully the mellow yellow tints of the poplars which deepen day by day. The forests never attain the brilliance however, of those of southern Ontario owing to the absence of the maple.

The first frost seen by the writer this season (1923) came on September 3, but it was too light materially to check the growth of the potatoes at New Post. In 1900 Niven and Burrows [12] report the first frosts observed by them on the James Bay slope to have occurred September 6 and 9. Ice usually closes the rivers early in November. The lower Abitibi is reported to have been open for canoes till November 19 in 1922. James Bay freezes over for a distance of many miles from shore in midwinter. It is reported[13] that snow melts and the rivers open during the latter half of April

[10] Most of the data regarding this snowfall were supplied by the Dominion Meteorological Service.

[11] These were identified by Dr. M. O. Malte, Chief Botanist of the Canadian National Herbarium, as *Aster salicifolius* Ait.?; *Aster Lindleyanus* T. & G.; *Solidago hispida* Muhl.; *Solidago canadensis* L.; *Allium Schoenoprasum* L. var. *sibiricum* (L.) Hartm.

[12] Report of the Survey and Exploration of Northern Ontario, Legislative Assembly of Ontario, 1900, pp. 55 and 72.

[13] J. M. Bell: Economic Resources of the Moose River Basin, *Rept. Ontario Bureau of Mines, Part I*, 1904, p. 175.

EXPLORATIONS IN NORTHWESTERN ALASKA*

By PHILIP S. SMITH
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In the preceding number of the *Geographical Review* Alaska is depicted as a land of potential resources.[1] Even these potentialities, however, are far from being fully known. There is, for instance, the case of the Naval Petroleum Reserve set apart in 1923, a tract of nearly 35,000 square miles of territory almost unknown except for a narrow fringe along the coast. The Navy Department, to whom administration was entrusted, requested the Geological Survey to explore the region and to prepare a report on its geographic and geologic conditions. In 1923 three parties, under the leadership of Sidney Paige, mapped much of the coastal portion, and in 1924 three other parties carried surveys into the southern part of the reserve and the adjacent country. Through these surveys and former investigations made by the Geological Survey in near-by areas the general characteristics of the country are now sufficiently well known to be described. The term northwestern Alaska, as here used, includes all of northern Alaska north of Noatak River (roughly latitude 68°) and west of the Anaktuvuk and Colville Rivers (approximately longitude 151°). In this tract about 25,000 square miles have been mapped, and in the remainder there are no points more than 40 miles distant from an area that has been mapped, and most are not as far away as 20 miles. In other words, practically all of the area has actually been seen, though some, of course, not in detail.

PEOPLE AND SETTLEMENTS

Not only is the region practically unknown to the whites, but it is scantily populated by the natives. Except near the coast and near the southern margin of the mountains forming the southern part of the area, the region is entirely unsettled, and only rarely do even natives traverse the inland parts of the region. During the entire time our parties were in northwestern Alaska in 1924 not a person was seen from the middle of the Unakserak, a tributary of the Alatna, to a point within a few miles of the coast nor, after the Survey party left Wainwright, until it reached the school and mission on the Noatak. The large settlements are at Point Hope, Wainwright, Barrow, and Point Barrow, at each of which except the last named there is a school, a store, and many houses. Here and there between these places are smaller settlements of natives, and practically everywhere along the coast are indications of former human oc-

* Published by permission of the Director of the U. S. Geological Survey.
[1] A. H. Brooks: The Value of Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 25–50.

cupation, but these signs seem to have been made by traveling or hunting parties. In the inland part of the region the signs of former human habitation proved rare and were made long ago. Formerly, however, there were many natives in the back country, and parties traversed it for game and to reach the spruce that grows on the south side of the mountains.

According to a rough estimate, less than a thousand people now live in that part of Alaska north of latitude 68° and west of longitude 151°. Of these people, less than twenty are whites, and all the rest are at least part Eskimo. The whites are engaged principally in trading or in ministering to the needs of the natives, including the conduct of schools and missions and stores and, at Barrow, the maintenance of a well-equipped hospital. The natives spend their time chiefly in hunting or in assisting in the activities of the whites. Formerly whaling was carried on extensively, but the decline in the price of whalebone and the substitution of mineral oils for whale oil has so adversely affected this industry that at present it is almost dead. Even hunting is less actively carried on now than formerly, partly because game has become less abundant near the settlements but mainly because the natives can make a living with less exertion by occasional service in the villages. In other words, even here in Arctic Alaska the transmutation of a rural to an urban population is in progress, with all the undesirable consequences of such a change. Many of the former customs and practices of the natives have disappeared with the coming of the whites, but their old friendliness, intelligence, proficiency in their own occupations, and interest in the doings of others still make these people not only interesting subjects of study but also good companions.

The Brooks Range

In broad terms the country may be divided into three rather distinct topographic units, which in order from south to north are the mountains, the plateaus, and the coastal plain.

The mountains trend in general east-west and are part of the great mountain region that extends eastward to the international boundary. To this major highland area the name Brooks Range has recently been given, in honor of the late Dr. Alfred H. Brooks, the distinguished explorer, geologist, and geographer who did more than any other man to make Alaska understood and appreciated. The Brooks Range is made up of groups of smaller mountain masses and will doubtless be further subdivided as the surveys of the region are completed. It is at least 150 miles wide; its higher peaks rise to elevations of 8000 feet or more, and its crest averages 5000 to 6000 feet above the sea. These mountains are formed of folded and deformed rocks of Paleozoic age which are here and there intruded by granitic masses. Veins bearing metallic minerals occur at places in the mountains, and some productive gold placers have been developed near the southern margin of the range, where the topography is less rugged

and more accessible than in the higher central parts. All the peaks can be climbed, although many of their slopes are precipitous and cannot be scaled by direct routes. At intervals across the range there are passes that can be traversed by loaded dog teams or by packers. The elevation of the pass traversed by Schrader in 1901 is about 2500 feet; that traversed by the parties of Smith and Mertie in 1924 is about 3900 feet; that traversed by Smith in 1911 is a little over 3800 feet, although near this place another

FIG. 1—Sketch map of Alaska showing position of Naval Petroleum Reserve No. 4 and the area covered in more detail by Fig. 2. Map furnished by U. S. Geological Survey. The scale is approximately 1: 25,000,000. Juneau is in latitude 57° 30′ N., longitude 134° 30′ W.

pass at an elevation of about 3000 feet was seen; and that traversed by Foran in 1924 is 3200 feet. In general the drainage of the Brooks Range in northwestern Alaska is northward or southward, being apparently consequent on the general constructional slopes of the mountain mass.

It is perhaps surprising to learn that in these mountains east of the 150th meridian only two or three glaciers, and these not more than a mile or two long, have been seen by the Survey's parties. The absence of glaciers is probably due to the very small precipitation. In the past, however, these mountains were the site of glaciers which formed near the higher parts of the range and flowed outward down the valleys, eroding them and giving them typical glaciated aspects. Apparently these old glaciers did not extend far beyond the front of the mountains on the north and nowhere reached the main Colville River. Moraines formed by these old glaciers have been trenched across by the larger side streams, the courses of which are thus obstructed for navigation even by canoes.

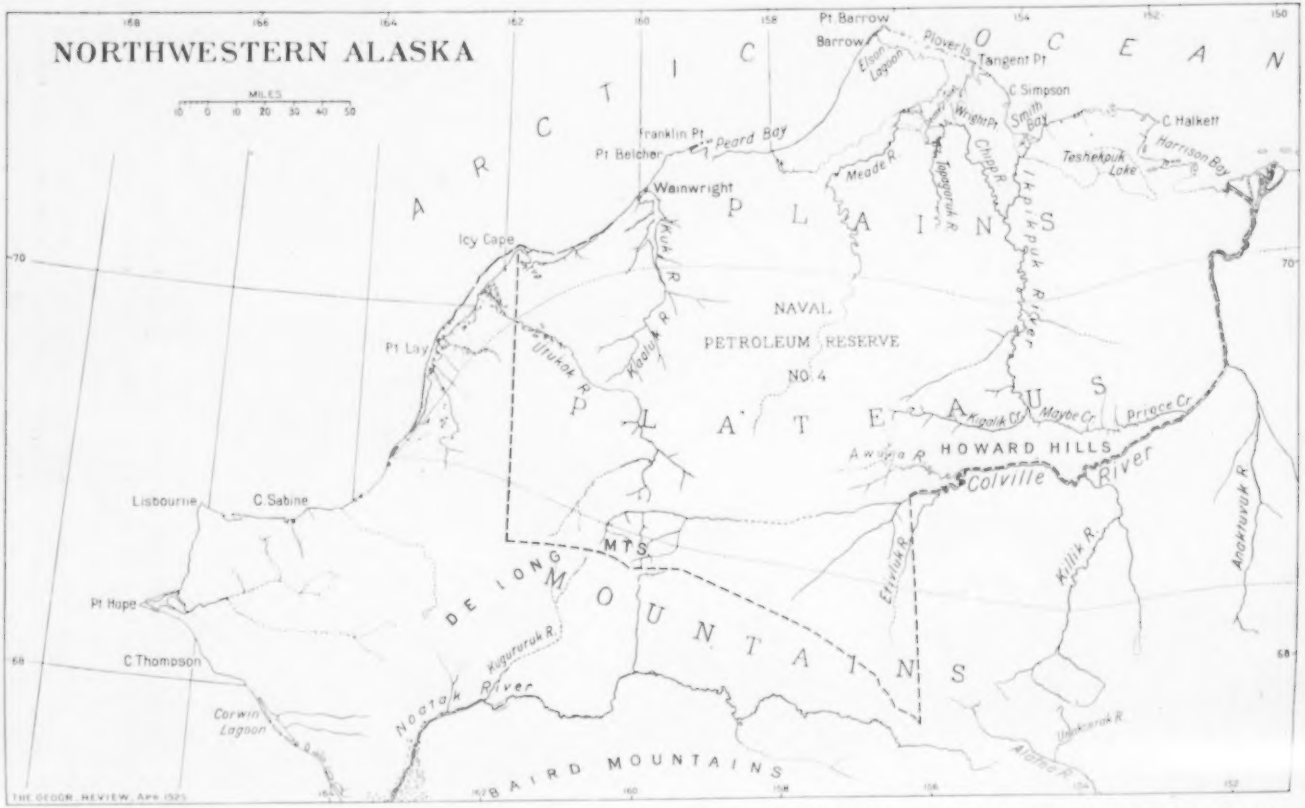

FIG. 3.—Map of Northwestern Alaska redrawn from the preliminary sketch "Northwestern Portion of Arctic Alaska," by the U. S. Geological Survey. Scale 1: 4,800,000.

The Plateaus North of the Mountains

At their northern limit the mountains end abruptly and are succeeded by gently rolling plateaus. Near the mountains the surface of the plateaus stands at an elevation of about 2000 feet, but farther north it becomes gradually lower until, 50 or 75 miles south of the coast it is only a few hundred feet high. The plateau region, as the term is here used, embraces a tract about 100 miles wide, formed of rather gently folded rocks, mainly sandstone and shale containing numerous coal beds. On the whole the rocks have a relatively low resistance to erosion, and their trend has in large part determined the direction of the streams. Erosion has not proceeded far enough to destroy much of the upland surface or to open out wide-floored valleys. The streams flow in fairly narrow valleys cut rather steeply below the uplands, and the larger streams have rocky walls along parts of their courses. Many of the small streams flow in shallow trenches cut only a few feet below the old surface. The larger part of the plateau region is drained eastward by the Colville and its tributaries, but the northern part drains northward to the Arctic Ocean by way of Ikpikpuk, Meade, and Kuk Rivers, and the western part by the Utukok and other streams that flow into the Arctic Ocean. The uplands of the plateau stretch away with a monotonous aspect, so undiversified that usually even the courses of the major drainage lines cannot be recognized from a distance of more than a few miles.

Coastal Plain and Coast Line

The coastal plain is a tract a few miles wide in the western part of the region that broadens toward the east until it is nearly 75 miles wide south of Barrow. Its surface is composed mainly of deposits of sand, mud, and gravel, unconsolidated except for ice, which fills the interstices and binds the materials firmly together. These deposits probably overlie rocks similar to those that are exposed farther south in the plateau region. The surface of this province as a whole is extremely monotonous. Sand dunes a few feet high near the courses of the larger streams are the only points that rise above the general level of the smooth plain. The larger rivers cross the coastal plain in channels that during low water have steep sandy or silty banks rising a few feet above the water, but during the period of high water in the spring these banks are submerged, as is also much of the adjacent country. The streams have tortuous courses through the coastal plain, and the northern parts of many of them appear to have been rather recently depressed below the sea, giving rise to estuaries. Near the coast many of the streams split into several channels or distributaries. By choosing the proper channel in such cases the traveler may avoid journeys along the exposed coast. For instance, it is reported that one may go from Peard Bay to Harrison Bay, an air-line distance of 150 miles, by an inside route with only two short portages, without having to traverse the Arctic Ocean.

FIG. 3

FIG. 4

FIG. 3—View up the Unakserak, a tributary of the Alatna, which affords the route that was followed in crossing the Brooks Range.

FIG. 4—Northern extreme of timber on the Unakserak, with the crest of the Brooks Range in the background.

FIG. 5

FIG. 6

FIG. 5—View from the summit of Survey Pass across the Brooks Range in April.
FIG. 6—View southward into Survey Pass, flanked by mountains about 6000 feet high, from the Colville side of the divide.

The coast in the eastern part of the region is indented by numerous bays, in most of which the water is very shallow, the land merging into the sea so gradually that at a distance of even a few miles the shore line cannot be distinguished. During the journey by canoe along the coast of the Arctic Ocean the west side of Smith Bay was entirely unrecognizable from the head of the bay, and even the shore not a mile away was inferred only from the presence of stranded logs along the beach, which apparently floated several feet up in the air. This effect was due to mirage, which is very common near the coast and which, together with the small relief of the country, makes the estimation of distances or the correct recognition of objects extremely difficult. One who has experienced these difficulties is willing to admit the truth of the story told by Stefansson, who relates that after he had stalked for an hour what he supposed to be a grizzly bear he found that the animal was only a marmot, which was sitting but a score of yards away from the point where his hunt began.

West of Point Barrow the coast is fronted by sand reefs, and trimmed by waves and currents so that it has long sweeping curves. Here and there where the ocean beats directly on the mainland it has cut cliffs, some of which are as much as 50 feet high. Where the mainland is protected by offshore sand reefs its coast line is more or less irregular, and the streams have built deltas into the lagoons that lie behind the reefs.

Climate and the Weather of 1924

It has been frequently pointed out that even northern Alaska is by no means a land of perpetual snow and ice. We are told that records made in New England or Montana show temperatures lower than any experienced during the 14 years for which records have been kept at Barrow, the northernmost part of northwestern Alaska. However, not to be misled by this statement, the reader should realize that it refers only to short-period minima, and although these are of interest they have less effect on life in a region than the average or mean temperature. The January temperatures in northern Alaska are about the same as those in the country adjacent to Hudson Bay, the July temperatures are about those of northern Newfoundland or Labrador. The mean temperature for the whole year at Barrow is approximately 10° F. As might be expected, however, the record at Barrow does not represent the temperature of the region as a whole. The extremes of temperature become greater southward from Barrow as the altitude is higher and the country is more remote from the ameliorating effect of the ocean. At Allakaket, about 350 miles south of Barrow, for instance, a much greater range of temperature has been recorded, the lowest temperature at these two places being, respectively, −54° and −70° and the highest 75° and 90°. The mean annual temperature at Allakaket is 18°.

Northwestern Alaska has an extremely arid climate, if judged by the records of precipitation, for according to these the average annual precipi-

FIG. 7

FIG. 8

FIG. 7—Winter headquarters in willow thicket in the mountains near the head of boating water on Killik River, a northward-flowing tributary of Colville River. Photograph taken April 12, 1924.

FIG. 8—View from a point near the same headquarters, showing contrast between winter and spring aspects of the region. Photograph taken May 23, 1924.

tation at Barrow is only 5.56 inches and at Allakaket 12.24 inches. The casual traveler, however, will probably not be sensible of this aridity, for in the summer, the season in which he is most likely to be abroad, the precipitation is heaviest, and if he is near the coast he will be enveloped and hindered many days by damp fogs and occasional showers that give him the notion that he has been constantly wet. Furthermore, the large amount of water which he sees everywhere on the surface and the marshes on most of the uplands will leave a lasting impression of a moist, swampy region, though the swampiness is due to the fact that the soil is frozen, so that the water is not carried away underground. Neither the vegetation that the traveler sees on every side nor the character of the erosion resembles that typical of the arid regions with which he is likely to be familiar.

The snowfall of the region is usually small, but the boisterous winds sweep it away from some places and pile it in great drifts in others, so that trails which are not used constantly soon become obliterated. On many of our trips tracks only a few hours old were entirely unrecognizable. Snow may fall in any month of the year, and, probably because we were least well prepared for them, the snowstorms in the summer were far more disagreeable than those in the winter.

The most significant events of the year are the closing of the streams and ocean in the fall and their opening in the spring, and all local chronology is dated from the "freeze-up" or the "break-up." The open season on the coast in the vicinity of Barrow—that is the period during which ships can traverse the Arctic Ocean—is practically limited to the month of August. It is true that in some years ships can reach this place about July 20 and that vessels have remained as late as the second week in September, but this extra season is made possible only by exceptionally favorable conditions or by taking grave hazards. In 1924 the Coast Guard steamer *Bear* was so badly crippled by ice in July that she was forced to turn southward for repairs without reaching Barrow; the trading and supply vessel *Arctic*, which reached Barrow the first week in August, was crushed by ice and became a total wreck a few miles south of the town on August 9; the Hudson's Bay Company's ship *Lady Kindersley* was caught in ice early in August and was abandoned as a total loss shortly before the end of that month; and the *Lettie C*, southbound from points east of Barrow, was caught in the ice and finally wrecked near Wainwright in September.

The "break-up" of the ice-bound streams proceeds progressively from their headwaters toward their mouths, so that there is considerable difference in the time of the "break-up" in different parts of the same valley. In 1924 the first small stream near our winter camp in the mountains broke up May 19; water was flowing by this camp in the main stream on May 28, and we were using canoes on May 31.

The prevailing winds of northwestern Alaska are east or northeast. In the mountains the winds tend to follow the larger valleys, so that their direction is much more variable and inconstant than over the regions of low

topographic relief. Actual as well as sensible temperatures are very materially affected by the occurrence or the absence of wind. On a quiet day a temperature of as much as 30° below zero is not at all unpleasant if one is suitably clothed; but on a windy day a temperature of zero, other conditions being the same, is much less bearable. People familiar with the region during the winter state that when strong winds begin, the only thing one

FIG. 9—Typical camp on the divide between the Colville and Ikpikpuk basins. Note the absence of brush: the canoes are used as side stakes for tying the tent. Tent poles and pegs were carried by the Expedition owing to the absence of wood in the region.

caught out in such weather can do is to "hole-up" in a sleeping bag or with such protection as may be had until the blow is over.

By the time our parties reached the region, early in March, we had a twelve-hour day without the need of artificial light; by late April it was sufficiently light to enable us to travel all night and see the trail rather distinctly, and from the third week of May until the last week in July in latitude 69° the sun was above the horizon all the time. Even in the later part of August it was so light that we could plainly see landmarks throughout the night.

TREES AND PLANTS

Practically all of northwestern Alaska lies north of the limits of trees, as we of more southern latitudes use the term. The "farthest north" for spruce on the Unakserak is ten miles south of the summit of Survey Pass;

on the Alatna, about four miles below the portage leading from that stream to the Noatak; and the farthest north and east on the Noatak is near the mouth of the canyon above Kugururuk River. Even in these valleys spruce is restricted to the valley floors or the lower slopes, and throughout the greater part of the region the only wood available is furnished by willows. Even the willows are confined to a narrow fringe along the streams; the mountain slopes and the uplands of the plateaus and plains are entirely bare of trees or bushes. Doubtless temperature, soil, and other elements influence or determine the distribution of the trees and bushes, but wind is probably also potent in controlling their distribution. Throughout the valleys of the mountain and plateau area traversed willows are sufficiently abundant to furnish camp fuel if the camp site is properly selected. In the coastal plain province even bushes are far apart and too small to use as fuel. Fortunately, in this region we found that driftwood which had been brought down by the rivers from the willow thickets farther upstream or by ocean currents from the spruce and cottonwood forests of the Mackenzie or the Yukon was sufficiently abundant to supply all camp needs if assiduously gathered from the bars and banks as we traveled.

The plateau country back of the fringe of willows or alders that line the streams is generally covered with moss or grass and here and there with numerous small, prostrate woody shrubs. The grasses and sedges are mostly coarse and do not appear to be suitable for horse feed, though at a few places, especially along the borders of the streams between the water and the fringe of willows, patches of grass similar to redtop were noted. The whole vegetation forms a spongy mat, difficult and tiresome to traverse except along the better-drained crests of the ridges, where it becomes thin and particles of the disintegrated underlying bedrock are abundant. In the larger part of the Colville basin the willows were not in full leaf until well into July, and killing frosts occurred late in August, so that the growing season is very short. In the mountains much of the surface away from the streams is formed of bare ledges or talus, and, except for the abundant lichens that grow on the rocks, vegetation is scanty. It is interesting to note, however, that even on the steep slopes of many of the higher hills wild sheep browsed on this scanty vegetation and apparently found it sufficient.

Berries were seen at a number of places in the plateau region, but they were not plentiful enough to contribute materially to our food supply. Salmonberries and cranberries were the most abundant. Although blueberry bushes were common, the season of 1924 was apparently too backward to ripen the berries. The beauty of many of the scenes was enhanced by a great profusion of flowers. The snow was hardly off the ground before the hardy plants were in bloom and the benches near the streams were dotted with white, purple, yellow, and pink flowers.

Animals and Wild Life

In a frontier region the number and the distribution of animals are matters of vital concern, for animals may contribute largely to the food supply and may furnish clothing as well as material for covering boats and houses or for constructing implements and equipment. Throughout most of northwestern Alaska wild animals are so numerous that they supply many of the needs of the present population, though in the vicinity of the settlements they have been killed off, so that they must be hunted in more remote regions.

In the mountains the most abundant large animals are mountain sheep, whose meat forms a delicious food and whose hides are said to make the most durable clothing and sleeping bags. Before the advent of the whites their horns were extensively used in the manufacture of ladles and similar culinary articles. These animals live on the higher peaks in the less accessible parts of the region and are now little hunted, so that they are often seen in flocks of 10 to 30. North of the mountains, in the plateaus, the commonest large animals are caribou. No large herds of these animals were seen, but almost everywhere in the plateau region search for them discovered groups of 2 to 15. Caribou are valuable for their meat, hides, sinew, and antlers. Formerly these animals were extensively hunted, but nowadays the herds of reindeer that are grazed near the coast furnish a much more convenient source of supply, so that the caribou in the remote parts of the region have been less molested.

Foxes, notably the white fox, which is found near the coast and on the sea ice, probably furnish the most valuable part of the fur that is shipped out of the country. Red, cross, and black foxes were seen in almost all parts of the region from the mountains to the coast. Bear are said to be rather common in the southern part of the Brooks Range, but only a few signs of these animals were seen north of the mountains, and probably they are not numerous in any of the inland country, though polar bear are frequently obtained near the coast and on the ice pack offshore. Rabbits are numerous in the mountains and during a good season can probably be relied on as a source of food.

Birds are numerous. The birds most used for food are ducks and geese near the coast and ptarmigan in the plateaus and mountains, though swans and cranes are also hunted as food. The first northward-bound geese passed over our camp in the mountains on May 7, and for the next few weeks flocks, many of them including several score, passed at frequent intervals. On reaching the Arctic Ocean, late in August, we saw enormous flocks of ducks—in fact, in the stretch from the head of Smith Bay to Tangent Point, as we paddled along in the evening, we saw the water in places literally black with thousands of them. Not only are many of the birds of the region valuable as food, but the skins of some of them are used by the natives for clothing or for the decoration of small articles. Other birds that were commonly seen but that are not hunted, except under stress of

FIG. 10

FIG. 11

FIG. 12

FIG. 10—First open water a few miles below winter headquarters on Killik River. Hundreds of grayling lived in this pool. Photograph taken May 26, 1924.

FIG. 11—The Killik River crossing the morainic belt in the plateau province. The river flows in a channel at the base of the first snowbanks beyond the near lake.

FIG. 12—Characteristic topography of the plateau province, with channels of Killik River in foreground, which have been cut through overflow ice formed during the preceding winter. Photograph taken June 9, 1924.

FIG. 13

FIG. 14

FIG. 15

FIG. 13—View southward up Killik River from point above its junction with the Colville, showing the general aspects of the plateau region and the larger streams that flow across it. Photograph taken June 18, 1924.

FIG. 14—View westward in the plateau region, looking toward the head of one of the western tributaries of the Colville.

FIG. 15—Small northward-flowing tributary of the Ikpikpuk. The upland in the background is the nearly smooth plateau that forms the divide between this stream and the Colville.

hunger, are robins, camp robbers, eagles, hawks, owls, snipe, loons, and gulls.

No account of the wild life of northwestern Alaska would be complete if it omitted mention of the insects. From July 15 to August 10 mosquitoes, gnats, and related small stinging insects made life in the open almost unendurable. Most of the members of the party wore veils continuously when out of doors and built smudges whenever they were not in motion. Flies were common around our winter camp many days before the streams broke and were seen in Barrow at the beginning of September. Insect parasites were found on many of the animals killed. More agreeable members of the great class of insects were the bumblebees and butterflies, which during the summer were fairly common throughout most of the open lowlands of the plateau province.

Resources

In the foregoing description an attempt has been made to portray northwestern Alaska as it is. Now comes the larger questions—What will this region become? What are its resources and its potentialities? Prophecy is a hazardous undertaking under any conditions, and it is especially hazardous for a region such as this, where many of the essential data are not available. It is certain, however, that the region contains large reserves of natural products and that it is not so inhospitable as to preclude further settlement.

Unquestionably petroleum occurs in the region, as is proved by the seeps that have been examined by the Geological Survey at Cape Simpson. How widely distributed are the oil sands, how much oil do the productive beds contain, and what are the proper methods of winning the oil are technical questions that cannot yet be answered, though some of the problems involved are in course of solution. It seems certain that when the struggle for oil reaches a more acute stage, owing to the depletion of the more accessible oil fields, northwestern Alaska may be listed among the places in which oil will be sought. Another of the great but still undeveloped natural resources of northwestern Alaska is coal. More than a dozen beds of subbituminous and bituminous coal that range from 4 to 20 feet in thickness are known, and coal-bearing rocks have been found through a belt of country more than 100 miles wide and 300 miles long. Probably these deposits will be used first in local development within the region, where, because of the absence of other fuel, they will have especial value. There is little reason to doubt, however, that as development of the country proceeds some of this coal may be sent to more remote markets, for many of the beds crop out near the coast, where the coal could be lightered to seagoing vessels. Metallic minerals may be sought with some assurance of success near the southern limits of the mountains, where the older rocks occur, and even in the geologically later rocks that form the central and northern

FIG. 16

FIG. 17

FIG. 18

FIG. 16—Ikpikpuk River in its coastal part, about 40 miles in an air line from its mouth.

FIG. 17—Ice packed so solidly against coast at Barrow, on August 22, that no stretch of water large enough to float a canoe was visible as far as the eye could see.

FIG. 18—Ice pack at Barrow beginning to open up through the influence of strong easterly winds. The trading post and native settlement are seen in the distance across the lake. Photograph taken August 31, 1924.

parts of the Brooks Range, in those places where igneous intrusions have brought ore-bearing solutions from deep-seated sources to the zone that is now exposed by erosion. Although the first output from this source will be obtained from deposits that are easily mined, such as gold placers, the physical history of the mountains suggests that such deposits are irregularly distributed and that a permanent metallic mining industry must depend upon the development of lodes.

The region does not appear to hold promise for agricultural development. To one who has seen the tender solicitude displayed by some of the people living near the coast in raising a few leaves of lettuce or a few radishes, it is obvious that cultivation of crops that would be likely to contribute in appreciable quantities directly to the food supply is improbable. The vegetation of the region can, however, make an indirect contribution thereto, for there are thousands of square miles of the plains and plateau region that are in all essential respects similar to regions in which reindeer are now being successfully pastured. Although the present scanty population and the great distance from market make grazing in this region now a venture that should be undertaken only with full knowledge of its speculative character, nevertheless there is justification for the forecast that when the other resources of this region are more developed and when the agricultural possibilities of more favored regions are more fully utilized for crops, grazing in northwestern Alaska may become an important business.

As the development of a wild region progresses, game is driven out or exterminated. A long time, however, will elapse before this country reaches that stage, and until then it can furnish many more furs than it does now. Hunting and trapping are therefore among the enterprises likely to increase first as the region is developed, and, as they always have been, they will in themselves be a cause of its increased development. The waters off this coast have furnished many animals and fish that were profitably caught by the whites when the Arctic Ocean was uncharted and the adjacent country was inhabited only by Eskimos. Their crop has not been exhausted and may long be counted on as one of the great resources of the region. All these resources interact, so that the successful development of one inevitably stimulates that of the others. He would be a pessimist indeed who did not regard the resources of northwestern Alaska as valuable future assets of our country.

THE EARTH'S EVOLUTION*

By Sir Napier Shaw

The Argument

Here we must bring this study of the earth's evolution to a close. Its fundamental principle has been that the present, if rightly understood, affords a full key to the past. . . . We have endeavored to discover new truth concerning the physical environment that has molded the evolution of all life.

In these words Professors Huntington and Visher sum up their achievements in the companion volumes "Earth and Sun" and "Climatic Changes." The study is so extensive, both in its range and its claim on the reader, that it will be best first to trace the line of the argument so far as it can be formulated by a retentive reader.

The predominant influence of physical environment is with the atmosphere, the changes in which we call weather. Those changes may be summarized or generalized as climate, which itself has been subject to change throughout the geological era of the evolution of life. The primary control of weather and consequently of climate lies in the play between the influence of the sun, which operates by radiation, mainly perhaps thermally but also, to some extent, electrically, and the counter-radiation of the earth, which is also mainly thermal but still must have its electrical or electronic share; both are dependent upon temperature. The primary cause of changes in climate of a temporary nature, such as have been disclosed by Douglass' investigation of the rings of the *Sequoia* and other evidences, during the historic period, lies in the variations in the sun's radiation, thermal and electrical; the activity of the sun is greater at times of maxima of sun spots and less at times of minima. If we suppose the variations in solar activity exaggerated from time to time, at intervals of tens or hundreds of thousands of years instead of the day, the year, or group of few years of the historic period, greater changes of climate would naturally be produced, such as those represented within historic times by the remarkable climatic stress of the fourteenth century, in prehistoric times by the last ice age, and in geological times by the ice ages of the geologic past with the intervening periods of mild climate, much warmer than that of the present day, for which millions of years are required. We can associate the well-known period of the variation of sun spots of about eleven years with the periodic changes in the positions of the planets, particularly of Jupiter and Saturn. We can, therefore, associate the minor changes of the historical period with the approaches of those heavenly bodies to the sun, yet

* Ellsworth Huntington: Earth and Sun. Yale University Press, 1923.
Ellsworth Huntington and S. S. Visher: Climatic Changes: Their Nature and Causes. Yale University Press, 1922.

we can find no explanation of the increased activity of the sun in the increased gravitational force of those bodies nor yet in the tidal effect produced by the rotation of the sun under their increased gravitational force.

> The agency through which the planets influence the solar atmosphere is not yet clear. The suggested agencies are the direct pull of gravitation, the tidal effect of the planets, and an electro-magnetic effect. In *Earth and Sun* the conclusion is reached that the first two are out of the question, a conclusion in which E. W. Brown acquiesces. Unless some unknown cause is appealed to, this leaves an electro-magnetic hypothesis as the only one which has a reasonable foundation. Schuster inclines to this view.[1]

Proceeding from a quotation from O. W. Richardson[2] we next arrive at the conception of an electromagnetic hypothesis as explaining the variation of solar activity with the natural extension to assume that, according to its temperature, every body in the universe must be thermionic and act electromagnetically upon every other body with an intensity that depends on the area of the influencing body and inversely as some power of the distance. In order to account for the major changes in the sun's activity which have caused the great fluctuations in climate within geologic times, the planetary influences are too small; but the power of the stars may be invoked; we have only to look out in the universe for suitable visiting stars. With Professor Schlesinger's assistance we find that there are twenty-six which might do something[3]: four of them, Sirius, Altair, Alpha Centauri, and Procyon are the chief. From their positions, assuming their electrical influence to be proportional to their known luminosity, we can construct a curve of disturbance of the past and future extending 70,000 years either way, which gives a fair estimate of the date of the last glacial epoch and insures us against another for 70,000 years.[4]

We are not to forget that the distribution of land and water is a recognized element of terrestrial climate; but even the changes in that distribution may be regarded as secondary effects of atmospheric changes, because even earthquakes, which represent the readjustment of land areas under stress of contraction or increased angular velocity, are found on inquiry to be dependent upon weather, being most frequent in winter when storms are also most frequent.[5]

To put the whole conclusion in a sentence, evolution, both physical and biological, is a function of the exchange of electromagnetic radiation or influence among the heavenly bodies, sun, planets, and stars, and is controlled by the relative positions of those bodies. We begin again with a new astrology freed from the assumptions which have degraded that science since the time of the Babylonian astronomers and based upon a rational extension of modern electromagnetic theory.

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[1] Climatic Changes, p. 244.
[2] *Ibid.*, p. 256.
[3] *Ibid.*, pp. 276–277.
[4] *Ibid.*, p. 278.
[5] *Ibid.*, Ch. 16.

The Sciences Invoked

The steps to this conclusion, as stupendous apparently as the law of gravitation itself, are the various chapters of the two books. "Earth and Sun" gives the evidence for the use of sun spots as an indication of solar activity, explores the possibility of the influence of electrical radiation upon climate, and deals with the causation of sun spots by planetary influence. In "Climatic Changes" the uniformity and variability of climate in geological times are examined, the historical changes of climate are discussed, the problems of glacial and interglacial periods are exposed. The possible causes of change in the sun's atmosphere and the earth's atmosphere are considered, and finally we are initiated into the general stellar-solar hypothesis of climatic change. By way of appendix the geological changes in the earth's crust are dealt with in the manner already described.

These are such magnificent sweeps of the magic wand of science that it is not at all clear with which of the sciences ancillary to geography the subject should be specially associated. The problem is primarily geological; it is the change of climate in geologic time for which an explanation is sought; the "works" of the machine by which the problem is handled are made up of history, solar physics, electricity in its most modern form, stellar physics, and astronomy, as well as biology. But the cutting edge of the machine is in fact meteorology, because the real object of the research, climate, or generalized weather, is the result of atmospheric changes, and all the electrical, planetary, and stellar influences must be ultimately expressed in terms of meteorological elements—temperature, rainfall, "storminess" or pressure gradient. Biology comes in as a criterion, after a preliminary discussion of the evidence of comparative uniformity of climate throughout the ages of geologic time, by the continuity of organic life which could not tolerate any very wide departure from the physical conditions to which it has become accustomed. And here, parenthetically, we may remark that, of all the conceptions with which they deal, life appeals to the authors as the eternally immutable. Environment may destroy lives, but it cannot really alter life. The sun may vary, the mountains disappear in the ocean, and all things apparently be in course of change; but, in spite of the millions of years that have elapsed, coal in the Arctic and "warmth-loving" creatures in the polar regions are accepted as undeniable evidence of change of *climate*, not of change in *life*.

> The stars shall fade away, the sun himself
> Grow dim with age, and nature sink in years,
> But thou shalt flourish in immortal youth
> Unhurt amidst the war of elements,
> The wreck of matter and the crash of worlds.

So vast is the range of the sciences invoked in the discussion of the earth's evolution that few readers can be in a position to undertake a critical appreciation of the whole. Students of atmospheric electricity may wonder

whether the potential gradient at the surface, which has been chosen as the criterion of electrical variation under solar influence, is really the proper element for that kind of inquiry, considering how liable it is to influences of the most mundane character—dust and snow and the things which are of the earth earthy. They may also wonder whether any reasoning based upon area as distinguished from mass is really effective in the case of the heavenly bodies, which may consist of tenuous atmospheres. A recent number of *Nature*, for example, gives the pressure of the sun's atmosphere at the level of the photosphere as only 100 millibars. And altogether the electromagnetic influences which are presumed to be operative over thousands of millions of miles are only sketchy. Still, we all know that electricity is a very potent influence, and we must be content to have it treated in a sketchy manner until we know more about it. But, frankly, we do not like the reasoning that since only three suggestions are offered and two of them have been proved to be unworkable the third must be accepted. Inductive sciences have never found that to be a very satisfactory mode of procedure. Its ultimate foundation is ignorance, and science is knowledge.

Of those things the experts of the several sciences must be left to give their opinion if they so desire. The cutting edge of the machine is, as we have said, meteorological. Yet internal evidence goes to show that the mental attitude of the authors is not exactly that which is common among meteorologists. We are accustomed to a curious meticulous accuracy in small details that is offended by such trifling defects as misprinting "de Quervain" as "Guervain" and other similar slips with the names of authors referred to in the text and notes. Further, in the discussion of electrical potential gradient, data are quoted for Kew Observatory which are not known to exist at the Observatory itself. And the sensitiveness about these trifling inaccuracies is only one aspect of a cautiousness which is habitual with meteorologists because they are constrained not only as regards references and data but also as regards inferences and conclusions. They have not the spacious liberty of the geologist or the astronomer or the biologist. Any scientific inference which a meteorologist draws from the facts of the present or the past is liable to be confronted with actual facts within a few hours or days or years; and he feels uncomfortable and nebulous about conclusions expressed in "par-secs" or "light years," or even in the millions of years of geologic time, which are out of range of the means of verification customary in meteorology. No meteorologist, for example, could pen the following sentences: "Each of these secondary hypotheses is in its way important. Yet any or all may prove untrue without altering our main conclusions." He could not bring himself to say anything was important which did not matter. And both books abound in remarks of a somewhat similar character. One is repeatedly reminded of the politician's address to his constituents, "These are my views, but if you do not like them they can be altered." "The conditions which any satisfactory climatic hypothesis must satisfy are briefly as follows:" due weight must be

given to this, attention paid to that, etc. For a meteorologist the only criterion for a satisfactory climatic hypothesis is agreement with the facts, nothing more and nothing less. It is natural for him to feel that a clear statement of the salient facts should precede an effort to compile a theory.

This apparent detachment from the care which rides at the back of the ordinary mortal in his efforts to make out the riddle of the physical universe leads to an Olympian style and arrangement. We are invited to begin the study of climatic changes, not with the humble question of the evidences of change of climate beginning with the day and carried on through the year and periods of years to geological eons, but with a Jovian summary of the types of climatic sequence in progress: (1) cosmic uniformity, (2) secular progression, (3) geologic oscillations, (4) glacial fluctuations, (5) orbital precessions, (6) historical pulsations, (7) Brückner periods, (8) sun-spot cycles, (9) seasonal alternations, (10) pleionian migrations, (11) cyclonic vacillations, (12) daily vibrations; and for each in turn we are invited to adopt a hypothesis which may become a theory. A meteorologist of ordinary humility would have gone the other way of the ladder, would have begun at the bottom with changes of which he had indisputable evidence and would have gradually extended his range of vision; he would have looked forward to that table of climatic changes as a triumphant final conclusion of his exposition of the variability of climate and would have led up to it in his last chapter instead of putting it in the first paragraph.

Still these are mere scientific idiosyncrasies; the evidence is the evidence all the same.

The Steps of the Edifice

If we examine the several steps which lead to the final conclusion we may find a good deal of opportunity for discussion. The reasoning is often of an inconclusive character, and one develops a bad habit of challenging almost every sentence—a habit that makes books very hard to read.

Take, for example, a theme of which a good deal is made, though it is not of very vital importance so long as the facts are sound: "A hot sun and a cool earth."[6] That is an apparent paradox taken over by the authors with some emendation from Professor W. J. Humphreys, who has displayed his usual ingenuity in expounding it. But it is a paradox about which any ordinary meteorologist must feel convinced that there is a snag somewhere. Imagine the consequences of it when it is paraphrased as "the greater the amount of solar radiation the cooler the earth." For the separate hemispheres it conflicts with our experience of summer and winter; and if, as we all believe, the earth would be colder if the sun were extinguished altogether, it implies that somewhere between zero and normal radiation there is an optimum value which would give maximum warmth on the earth, "a thing imagination boggles at." The betting is a thousand

[6] Earth and Sun, Ch. 4.

to one on something logarithmic against a conic-sectional representation. But in enunciating and discussing this paradox the authors do not state clearly the origin of the data from which the conclusion is derived. Let us put an alternative in syllogistic form: (1) The mean temperature of land areas in the tropics is *lowered* by the presence of cloud. One could easily support that statement by statistics of British India. (2) *Cloud over the land areas* is derived from the evaporation of water from seas and lakes. A vague statement but, in our authors' phraseology, "not unreasonable." (3) *Evaporation from seas and lakes* is increased by the *increase* of temperature of the water. Almost undeniable. Hence *hot seas* mean *cool land areas;* and, if the estimate of the temperature of the earth is taken from land observations alone, a false conclusion may easily be arrived at.

Or take another and more vital example. The authors suggest in "Climatic Changes"[7] that *diminished* storminess over the Atlantic Ocean means *increased* westerly winds; they give diagrams to enforce and illustrate the conclusion. That is certainly a surprise for ordinary meteorologists. Not only would they think that the westerly winds, being an essential part of the general circulation of the atmosphere, and the cyclonic disturbances, being another essential part of the same circulation, would increase together, if not *pari passu* at any rate in association one with the other; but, further, they generally regard the superposition of a cyclonic depression upon a normal circulation as increasing the westerlies on its southern side by quite as much as it reduces westerlies or supplies easterlies on its northern side; that feature is apparent in untold numbers of weather charts of the Atlantic Ocean. If so, increased storminess means increased westerlies in the area under consideration.

We say little about the measures of storminess and pressure gradients upon which is based much of the meteorological work of the books, only that it is rather a reversal of the adage *ex pede Herculem* into *ex Hercule pedem*; the path of nature is judged by an examination of one of her creations—the number of cyclonic centers in the United States in the one case, and a curious estimate of the state of pressure over the North Atlantic in the other. For years we have been on the lookout for some feature of the atmospheric circulation that could be regarded as a trustworthy index of the whole activity. The trade winds strike one as being the most promising, but there are many others; and we hesitate to accept the rather arbitrary definitions of storminess or gradient which the authors have used without some inquiry into their relation to the other features of the general circulation. Meanwhile the authors may be glad to know that the Dekadenbericht of the Deutsche Seewarte is not the only or even the most complete source of information about meteorological conditions day by day over the Atlantic; the charts published for many years by the Danish Office and the Seewarte conjointly, in continuation of Hoffmeyer's charts, are much more complete and would have been more effective for their purpose.

[7] Climatic Changes, Ch. 10.

The Method of Correlation

But we have a remark or two to make about the applications of the method of correlation which are to be found in the various chapters of the books under review but not by any means, be it said, in these books alone. The dictum of the statisticians that a correlation coefficient has real significance if it is three or four times its probable error is responsible for much expenditure of time on objects that are not really worth it. In the cases in question we have nothing to complain of in the application of the method to the relation between rainfall and the growth of trees, for which the correlation coefficients are of the order of 0.4 to 0.6. They make good a claim, "bar accidents," to a quarter of the tree growth, but the correlations between sun spots and meteorological data,[8] laborious as the work of compiling them must have been, are ludicrous, especially in their monthly irregularity, as expressing a reasoned relation in view of the arbitrary character of the data both solar and terrestrial. Barometric pressure and rainfall would not be regarded in these days as having more than a very vague relationship for Kew; but its correlation coefficient is ten times that of sun spots. We are told by our statistical friends that the square of the correlation coefficient indicates the fraction of the one quantity that is controlled by the other. If so, it is not really worth while to pursue correlation coefficients less than 0.3, which allows only ten per cent of reciprocal control, except in those cases where the quantities are so well-defined and the data are so numerous that the laws of probability based upon great numbers of observations can be implicitly relied upon. We may have complete confidence in a correlation coefficient between the phase of the moon and the atmospheric pressure at some point on the earth's surface because both measurements are precise and almost unlimited in number; but with arbitrary definitions of meterological features and such a vague element as sun spots, labor is only justified by coefficients of large magnitude.

Perhaps, however, the limit of the method of correlation is reached where[9] the relation between sun spots and earthquakes in the same month is worked out as + 0.042, or 1.5 times the probable error; sun spots of a given month and earthquakes of that month and the next as + 0.084, or 3.1 times the probable error; sun spots of three consecutive months and earthquakes of three consecutive months allowing a lag of a month as + 0.112, or 4.1 times the probable error. The coefficients are so small that the conclusion to be drawn is that other causes than sun spots account for at least 79 earthquakes out of 80.

The Conclusions

All these considerations leave us doubtful about the conclusions. The fact is that one of the most noticeable habits of the authors is to put for-

[8] Earth and Sun, Table 18, p. 129, and Table 19, pp. 131–132.
[9] Climatic Changes, p. 291.

ward various hypotheses upon such facts as happen to be available and to disarm criticism by explaining that the hypothesis may be wrong after all but that the possible consequences of its being right are so important that they are impelled to offer the hypothesis, all unverified as it is, as an invitation to further study. This makes the work extremely difficult to read and still more difficult to describe. One is reminded of Mr. Puff's explanation of his histrionic reason for staging the loves of Tilburina and Whiskerandos, "things just so strange that though they never did they might happen." So with many of these relations meteorological, geological, astronomical, and biological, no one can agree that they are proved, yet nobody can say that they are untrue. Almost everything has to be left suggested but unsettled, for future researches to verify or contradict. As one passes page after page one becomes moved to remind the authors that the sciences of physical astronomy, or stellar physics, geology, and meteorology too are still in the inductive stage and require to be so treated. The primary requirement of the day is coördination of facts without too much guidance by hypothesis that may prove a will o' the wisp. In one sentence Mr. H. G. Wells is put on one side as an unscientific writer; but, however unscientific he may be, he does stand for coördinated facts as the preliminary of social as of scientific theory; and if the authors could have seen their way to marshaling the ascertained facts of meteorology, geology, astronomy, and the other sciences pertinent to their inquiry in some encyclopedic manner easy of reference they would have made their books easy to read and refer to—much more so than is possible with a streaky alternation of fact and hypothesis in a many-folded sandwich. The shelves of meteorological libraries are already loaded with books and other forms of contribution to meteorological literature that have left no impress upon the science at all comparable with the effort necessary to produce them. That is particularly the case with books that arrange their facts according to their theory. It will be a matter of great regret if that should be the fate of "Climatic Changes" and its introductory volume "Earth and Sun."

Here we tender an apology for what may appear to the reader to be an unnecessarily critical attitude towards a work of profound interest and of great difficulty. It would certainly have been out of place if it had been possible for the vast subject to be more fully worked out. If, for example, the data had been sufficient for the authors to make out a detailed synthetic curve of the same kind as that which represents the changes due to stellar influences[10] but so that the changes of climate of the past two thousand or four thousand years could also have been represented in detail somewhat similar to Douglass' curve of tree growth, then any apparent imperfections of method would have had to give way to the logic of conclusions that are verified so far as facts are available for the purpose; but the authors themselves could hardly have regarded it as a compliment to postpone consideration of their theory until they had completed so formi-

[10] Climatic Changes, p. 279.

dable an undertaking. That would mean the shelving of the subject perhaps for a lifetime. They are themselves looking at the questions from the point of view of a tentative hypothesis which has hardly advanced so far as to be called a working hypothesis, and in the circumstances the methods rather than ascertained results must be the subject of critical consideration.

It is very desirable that geographers, geologists, astronomers, electricians, biologists, and meteorologists should be made aware that each requires the assistance and coöperation of the others; that in solving their own problems they contribute also to the solution of those of others. The amount of material that is embodied in the twenty-nine chapters is immense; and drawn from the authorities of so many different sciences the compilation represents a very useful as well as arduous task. The authors frankly ask for further investigation upon many points upon which there is at present no conclusive evidence. May we close this notice after the manner of "capping verses" by starting a hare of our own raising, for them to hunt. The cover in which it was put up is their chapter on the climate of history. It is this: By how much would it be necessary to increase the cloudiness of the region known as the "roof of the world" in Asia in order to cause famine in "the world as known to the ancients"? And in asking their acceptance of that small repayment in kind, we express our warm thanks to them for having invited and provoked a good many hours of strenuous thought on the interesting subjects which go to account for the earth's evolution.

NOTE ON THE PROGRESS OF DR. HAMILTON RICE'S SOUTH AMERICAN EXPEDITION

The plans for Dr. Hamilton Rice's expedition to the upper waters of the Branco and Orinoco Rivers were published (with a map) in the January, 1925, number of the *Geographical Review* (pp. 115–122). Some particulars of the progress of the expedition have been received in a letter from Dr. Rice to the Society dated Boa Vista, Upper Rio Branco, November 6, 1924.

Manáos was reached July 23. On this day revolution broke out. However, the plans of the expedition were in no wise affected. On the contrary everything was done to facilitate matters, and on every hand the characteristic Brazilian courtesy and helpfulness were met.

Vista Alegre, a hamlet on the left bank of the Rio Branco some 200 miles north of the point where it enters the Negro, or some 400 miles by water from Manáos, was selected as the site of the first base camp. The entire party and equipment were transported thither by the river steamer *Parahyba*, which also acted as mother ship for the hydroplane. Manáos was left August 20, and Carvoeira, near the mouth of the Rio Branco, was reached August 25. The following day the Rio Amajahú was ascended in the launch *Eleanor II*. This arm, which is about 40 miles long, branches from the Rio Xeriuhiry just before the latter enters the Rio Branco 25 miles or so above the main mouth, a feature incorrectly shown on all maps. On August 27 the main river was descended, and the Rio Negro was entered by the upper Marĭ-Mari passage. The three mouths are now correctly mapped.

On August 29 news was received on the Parahyba by wireless of the reduction of Obidos by Brazilian warships and of their passage to Manáos. The base camp was reached September 7. Here Mrs. Rice decided to return to the United States with Dr. and Mrs. Strong and other members of the Harvard School of Tropical Medicine unit who had completed their observations and collections in the Amazon Valley. On the return to Manáos Dr. Rice was detained for a considerable time over various matters, including repairs to the launch and the making of arrangements for the Venezuelan expedition complementary to his own. It was planned that the two sections should meet at the Serra Parima early in January. Manáos having been left again on October 12, travel was limited to daylight for the continued mapping (for the fifth time) of the intricate series of *paranas* and islands of the Anavilhana section of the Rio Negro. Vista Alegre was reached October 20.

On October 8 at Vista Alegre Dr. Koch Grünberg died of malignant malaria. Dr. George Shattuck, medical officer of the expedition, was in

attendance. The death of this distinguished ethnologist[1] was a most serious loss. He had had 25 years experience in exploration of tropical America, and great reliance had been placed on his knowledge of the territory.

From September 11 John W. Swanson at Boa Vista had been working night and day in the construction single-handed of the base radio station designed to send out as well as to receive messages. After seven weeks of hard and discouraging work the station was put into successful operation. Experience indicates that a trained wireless expert is indispensable to the topographical section of an expedition if a thoroughly reliable and accurate series of longitudes is to be obtained. An idea of the difficulties surrounding such work may be gained from the account of P. K. Boulnois and C. J. Aston ("Field-Longitudes by Wireless") in the *Geographical Journal* for April, 1924. The expedition hopes to maintain communications with Boa Vista up to the end of the journey to the Serra Parima, a difference in longitude of three degrees or more.

From the time of the expedition's departure from Manáos the proposed aerial photography has been consistently carried on by Captain A. W. Stevens. A valuable series of photographs has been secured from the Amazon up the Rio Negro to beyond Carvoeira and for the whole length of the Rio Branco. Captain Stevens has also done excellent work in map-sketching from the plane. He has an admirable team mate in Walter Hinton, the hydroplane pilot.

An important reconnaissance trip by hydroplane was made from Boa Vista on November 3. Leaving the station at 8 A. M., the plane followed the Rio Branco to the north, a landing being made at São Marcos, a hamlet near the ancient fort of São Joaquim formerly commanding the junction of the Uraricuera and Tacutu. Flight was resumed up the Uraricuera to Aparecido, a post consisting of a couple of houses only, where supplies for the expedition had already been forwarded. Thence Santa Rosa was made, at the eastern end of the large island of Maracá, which marks the last outpost to the west of the open grazing country over which roam thousands of half-wild cattle. Santa Rosa was reached at 2 P. M. The next day the plane left at 6.15 A. M., rapidly attaining a height of 5500 feet and an estimated speed of 90 miles an hour.

The southern *furo*, or channel, of the Uraricuera was followed to a point near the western end of Maracá Island when steadily increasing narrowness and clouds of mist from the many water bodies and streams made Hinton apprehensive as to whether this channel might not prove a cul-de-sac. He changed the course abruptly to the north flying over the densely forested island for ten miles until the larger northern channel was espied and westing again resumed, when it was soon seen that had the original course been held the western end of the island would have been reached. The southern *furo* is a series of boiling *caxoeiras* bordered by impenetrable,

[1] See the obituary notice in this number of the *Geographical Review*.

seemingly endless forest. For almost 50 miles farther west rapids and rocks continue to preclude the possibility of any hydroplane landing. Stevens declared that only once before in his flying experience had the terrain given rise to such a feeling of awe as that created by this savage wilderness—his flight during the previous year over the Grand Canyon of the Colorado, the Black Canyon, and Death Valley. Beyond, quiet waters flow with unbroken stretches suitable for landing purposes to the point reached on this trip, some 120 geographical miles as the crow flies short of the goal of the expedition. At 9.15 A.M. the plane was back, and landing was effected within four miles of Santa Rosa at a neighboring *fazenda*. Stevens worked on his sketch map a traverse from the hydroplane on the scale of 1:250,000. At noon the party was at Santa Rosa and, leaving this point at 3.06 P.M., reached Boa Vista at 5 P.M.

Reconnaissances and traverses have thus been carried by plane to within 120 geographical miles of the Serra Parima. The Rio Branco has been mapped on a scale of 1:250,000 from its mouths to the union of its component streams, the Uraricuera and Tacutu. Fixed points have been determined by many sets of astronomical observations for latitude and longitude obtained by Weld Arnold, assisted by Charles Bull, using the methods described in the plans for the expedition in the January number of the *Geographical Review* (pp. 117–118).

A wireless message received on January 28 reports that by January 19 the expedition had reached a point 3° 20′ N. latitude and 61° 55′ W. longitude, estimated at some 30 days from the mouth of the Parima River. It was anticipated that progress would continue to be slow for several days, but more favorable conditions were believed to exist farther on.

A wireless message dated February 24 reads: "Flight yesterday brought hydroplane within 100 miles of summit of Parima Range. One more flight will take to summit and complete aerial mapping. Present location 3° 50′ N. latitude, 63° 50′ W. longitude. Elevation river 1000 feet above sea level. Great difficulty bringing forward gasoline for return trip hydroplane. Supply at present over 100 miles behind it."

AN AID TO TRIANGULATION

THE USE IN SECONDARY TRIANGULATION OF SIMPLE FIGURES HAVING AN EXTERIOR POLE

By O. M. Miller

American Geographical Society's School of Surveying

As a preliminary to making a map a number of fixed points must be located in order to supply the necessary control for the detailed survey. This is done by measuring a trigonometrical framework or triangulation net over the country to be mapped. In respect to this, two main types of difficulties have to be confronted; firstly, the problem of choosing observation stations in such relative positions to one another that the resulting triangulation net is strong and capable of a rigorous adjustment and secondly, the problem of doing this quickly and economically. Unfortunately, the time and money question is usually the governing factor; and in making a choice the best scheme theoretically is nearly always discarded for a scheme not quite so good but considerably more economical.

With these considerations in view, in modern practice it is usual, except when operations of the most precise nature are contemplated, to restrict the triangulation net to a chain of consecutive simple figures, in which adjacent figures have only one side in common.

As a result the number of observations made is reduced to a minimum, and the labor of the adjustment of observation errors is very much lessened. However, this all adds to the difficulties of choosing the most suitable scheme in the first place, especially as the types of triangulation figures considered good practice are distinctly limited.

Supposing another type of simple figure could be found which would fulfill the necessary theoretical and practical requirements and which at the same time could be used in circumstances that debar the standard types of figure, then by utilizing this figure judiciously the difficulties of the initial reconnaissance should be lessened and the triangulation as a whole might possibly be executed more efficiently and economically than otherwise. It is the purpose of this paper to discuss such a figure, namely a polygon with an exterior pole. It is aimed to demonstrate that this simple figure may be adjusted easily by approximately rigorous methods; that the use of the tetragon with an exterior pole may be of real practical value to the surveyor engaged in secondary triangulation; and that this practical usefulness would not be likely in the case of a simple figure with an exterior pole composed of more than five stations.

Consequently, general rules for the adjustment of any simple figures are given, and it is shown how these may be applied to the particular case

of a tetragon with an exterior pole. Examples are given of the use of such figures under particular circumstances, and an endeavor has been made to arrive at a conclusion as to their relative value by a comparison of their theoretical weight with that of more conventional simple figures under similar conditions.

Simple Triangulation Figures

Adjustment by Successive Approximations

In primary geodetic surveying the errors of observation in a triangulation net are adjusted rigorously by the method of least squares; but in secondary work, where a larger margin of error is permissible, simple independent figures may be adjusted with sufficient accuracy by successive approximations, and the results differ but little from those obtained by a rigorous adjustment.

In the adjustment of any triangulation figure there are always two distinct types of conditional equations—the angle and side equations.[1]

In the approximately rigorous adjustment by successive approximations the angle equation adjustment is made first, and then with the corrected angles a solution of the side equation is made. The latter adjustment will generally slightly disturb the former adjustment, and the whole process must then be repeated with the resulting angles until both types of equation have been satisfied with sufficient accuracy.

This method of adjustment is confined, as a rule, to simple independent figures. A general definition of a simple figure is that it consists of a polygon to the corners of which rays have been drawn from a pole. The important characteristic of such a figure is that it involves in its adjustment only one side equation. Such figures usually take the form of a quadrilateral with both diagonals drawn, or a central pointed polygon; that is to say, a figure in which the pole is inside the area of the polygon.

This approximately rigorous method of adjusting a secondary triangulation has for many years been accepted as permissible, and most textbooks give at least a passing reference to it.[2] Lately, however, Captain G. T. McCaw has written a paper in which the subject is dealt with very fully and in such a way as to make its practical application a simple matter even to those not familiar with least-square methods.[3]

[1] Throughout this paper it is assumed that the angles have been measured by the method of independent angles and not by the method of directions.

[2] See, for instance, the following: T. W. Wright and J. F. Hayford: The Adjustment of Observations by the Method of Least Squares with Applications to Geodetic Work, 2nd edit., New York, 1906, Section 131 (pp. 177–179).

E. L. Ingram: Geodetic Surveying and the Adjustment of Observations (Method of Least Squares), New York and London, 1911, Section 59 (pp. 92–96).

J. B. Johnson and L. S. Smith: The Theory and Practice of Surveying, 17th edit., New York, 1910, Section 454 (p. 614).

E. R. Cary: Geodetic Surveying, New York, 1916, Section 60 (pp. 79–81).

[3] G. T. McCaw: Approximately Rigorous Adjustment of Simple Figures, *Geographical Section, General Staff, Technical Paper No. 1*, War Office, London, 1919.

A POLYGON WITH AN EXTERIOR POLE

In discussing the case of a central pointed triangle, Captain McCaw says, "This figure containing four stations is obviously a special case of the quadrilateral." It might, however, be said that the quadrilateral with both diagonals drawn is a special case of the central-pointed triangle, except that the central point, or pole, has been projected outside the area of the triangle (see Figs. I and II).

In practice, a closed quadrilateral is the kind of simple figure most frequently employed, but as far as the writer can ascertain, a figure with an exterior pole, consisting of five stations, has never been considered with a view to its adjustment by approximately rigorous methods. It is doubtful whether such a figure having six or more stations could be used

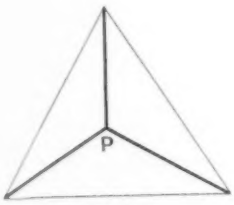


Fig. I.

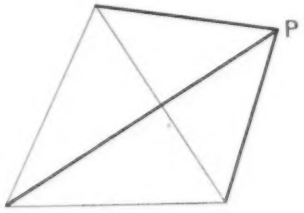


Fig. II.

to practical advantage in the field, because it is generally possible, where such a number of stations is to be employed, to build up a triangulation net as economically and with greater precision, composed of two contiguous simple figures (see Figs. III and IV and p. 277).

This is not the case, however, when one considers a five-pointed figure. Occasions must often occur where it is not possible to employ only one closed quadrilateral or central-pointed triangle as a particular link in the general scheme of triangulation and where the use of six stations is considered extravagant. The employment of a central-pointed tetragon is a conventional way out of the difficulty, but it is quite probable that local conditions could make even this arrangement impracticable. It is suggested that the use of a tetragon with an outside pole might on occasion solve the problem (see Figs. V, VI, and VII).

RULES FOR ADJUSTMENT

However, before discussing this type of figure it would be as well to devise some system of numbering the angles that is equally applicable to any simple figure and to summarize the rules for adjusting any such figure by the approximately rigorous method.

Suppose the polar station of any simple figure is lettered P, and the

sides of the closed polygon are lettered AB–BC–CD....., consecutively. The side equation may now be expressed in terms of the sides:

$$\frac{PB}{PA}\frac{PC}{PB}\frac{PD}{CP}\ \ldots\ldots\ldots\ldots\ldots\ \frac{PA}{PN} = 1.$$

As the sides of a triangle are proportional to the sines of their opposite angles, the side equation can be expressed in terms of the angles:

$$\frac{(\text{Sin } A}{(\text{Sin } B} \text{ in the } \triangle PAB) \times \frac{(\text{Sin } B}{(\text{Sin } C} \text{ in the } \triangle PBC) \ldots = 1.$$

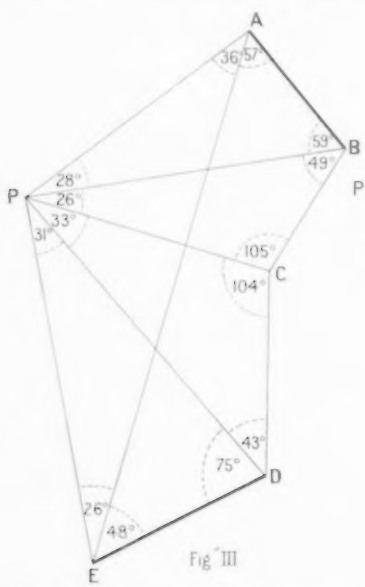


Fig. III

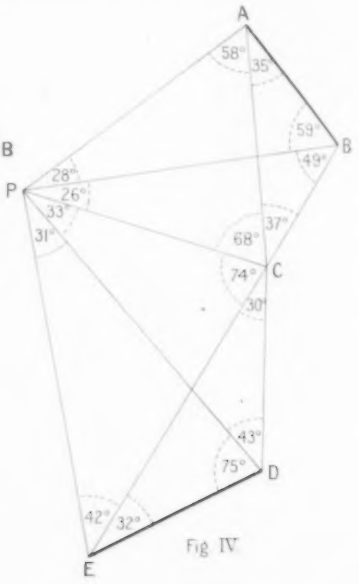


Fig. IV

Number the angles so that the side equation can now be written:

$$\frac{\text{Sin } 1}{\text{Sin } 2} \times \frac{\text{Sin } 3}{\text{Sin } 4} \times \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots = 1.$$

The angles at the pole are then numbered so that the first in order is the supplement of 1 and 2, and the second is the supplement of 3 and 4, and so on.

It is convenient to call the angles at the pole "polar angles," and the other numbered angles "side angles."

To solve the angle equations: If C_1, C_2, C_3,.....are the triangular errors, F the figural closing error, n the number of triangles in the figure, and x_1, x_2, x_3,...the total corrections to be applied to the angles 1, 2, 3, etc., respectively,

then the x correction to a side angle $= \frac{1}{3}C + \frac{1}{6}\frac{F}{n}$ .....(1)

and " " " " " polar " $= \frac{1}{3}C - \frac{1}{6}\frac{F}{n}$ .....(2)

Class 1. Class 2. Class 3.

Fig V

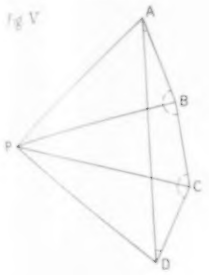


Fig VI

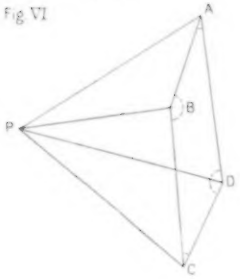


Fig VII

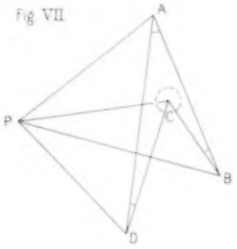


Fig VIII

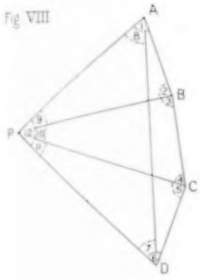


Fig IX

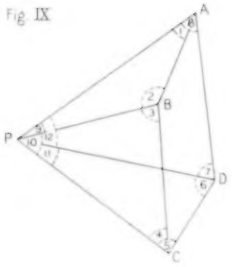


Fig X

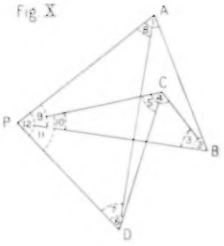


Fig XI

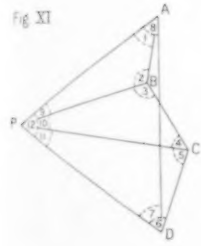


Fig XII

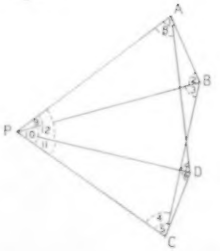
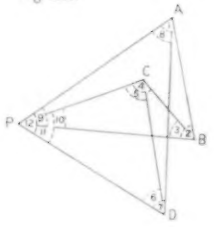


Fig XIII



Before making this adjustment it is essential that the polar angles be consistent one with another. For instance, in the case of a central-pointed polygon the polar angles should sum up to 360°. This condition may be called the polar-station equation.

To solve the side equation: If l is the difference between the sums of the log sines of the even side angles and the odd side angles, and if δ_1, δ_2..... δ_n are the differences for one second of arc in the log sines extracted for each angle, then $l/\Sigma\delta^2$ is a constant factor which, when multiplied by the δ of any angle, will give the correction in seconds of arc to be applied to this angle.[4]

[4] In the case of the closed quadrilateral the pole might be any one of the four observation stations, and, such being the case, the above rules would be applicable. However, in practice, the pole is taken as the point of intersection of the diagonals, and special rules have been devised for its approximately rigorous adjustment.

A Tetragon with an Exterior Pole

THREE CLASSES DEFINED

In the approximately rigorous adjustment of a tetragon with an exterior pole the preceding rules are theoretically applicable. However, for the purpose of solving the angle equations it is convenient to group this figure into three main classes (see Figs. V, VI, and VII) dependent on the manner in which the four triangles group themselves about the pole. It will be demonstrated later that these three classes indicate the three possible forms in which the conditions of figural closure for the remaining four stations can be expressed.

Number Figures VIII, IX, and X in the systematic manner previously suggested,

$$\text{then} \left\{ \begin{array}{l} \text{in Fig. VIII angles } 9 + 10 + 11 - 12 = 0 \text{ (Class 1)} \\ \text{“ “ IX “ } 9 + 10 - 11 - 12 = 0 \text{ (“ 2)} \\ \text{“ “ X “ } 9 - 10 + 11 - 12 = 0 \text{ (“ 3)} \end{array} \right\} \text{polar station equations.}$$

It is difficult at first glance to place Figures XI, XII, and XIII in their correct classes, but once the side equations have been formed, and the angles numbered in the manner stated, it will be apparent that these figures can be placed in Classes 1, 2, and 3 respectively.

ANGLE EQUATIONS

It is possible to express the conditions of figural closure for these types of figure by the following equations:

Class 1: angles $1 + 2 + 3 + 4 + 5 + 6 - 7 - 8 = 360°$ .....(3)
Class 2: angles $1 + 2 + 3 + 4 - 5 - 6 - 7 - 8 = 0$ .....(4)
Class 3: angles $1 + 2 - 3 - 4 + 5 + 6 - 7 - 8 = 0$ .....(5)

That these equations are true and equally applicable to either Figures VIII or XI in Class 1, and either Figures IX or XII in Class 2, and, again, to either Figures X or XIII in Class 3 can be easily proved.

It will be quite sufficient to demonstrate this fact with a single example. Suppose Figures IX and XII, both in Class 2, are examined.

In Figure IX the figural closure of the points A, B, C, D can be expressed in the form:

$$\text{angles } DAB + ABC + BCD + CDA = 360° \quad \ldots\ldots(6)$$

but the angle DAB = angles $(8 - 1)$
“ “ ABC = “ $360° - (2 + 3)$
“ “ BCD = “ $(5 - 4)$
and “ “ CDA = “ $(6 + 7)$.

Therefore, substituting in equation (6),

$$\text{angles } 8 - 1 + 360° - 2 - 3 + 5 - 4 + 6 + 7 = 360°$$

and, by rearranging,

$$\text{angles } 1 + 2 + 3 + 4 - 5 - 6 - 7 - 8 = 0 \quad \ldots\ldots(7)$$

Again, in Figure XII, the figural closure of the points A, B, C, D can be expressed in the form:

angles $DAB + ABC$ = angles $BCD + CDA$.....(8)

but the angle DAB = angles $(1 - 8)$

" " ABC = " $(2 + 3)$

" " BCD = " $(5 - 4)$

and " " CDA = " $(6 + 7)$.

Therefore, substituting in equation (8),

angles $1 - 8 + 2 + 3$ = angles $5 - 4 + 6 + 7$,

and, by rearranging,

angles $1 + 2 + 3 + 4 - 5 - 6 - 7 - 8 = 0$.....(9)

It will be apparent that equations (7) and (9) are similar to equation (4).

ADJUSTMENT BY SUCCESSIVE APPROXIMATIONS

Having got thus far, it is now possible to frame more detailed rules for the solution of the angle equations in the three classes of this figure.

Previous to making the adjustment as a whole it is essential that the polar-station equation be satisfied (see p. 271).

Now, in the notation as previously used, if C_1, C_2, C_3, and C_4 are the corrections to the closures of the triangles PAB, PBC, PCD, and PDA, respectively, and F is the correction to the figural closure of the stations A, B, C, D; and again, if $x_1, x_2, \ldots x_{12}$ are the corrections to each individual angle 1 to 12 in that order, then the following rules for the solving of the angle equations can be stated in tabulated form as in Table I.

TABLE I

x Correction	Applicable to all Classes	Class 1	Class 2	Class 3
$x_1 = x_2 =$	$+ \frac{1}{3} C_1$	$+ \frac{1}{4} F$	$+ \frac{1}{6} F$	$+ \frac{1}{24} F$
$x_3 = x_4 =$	$+ \frac{1}{3} C_2$	$+ \frac{1}{4} F$	$+ \frac{1}{4} F$	$- \frac{1}{24} F$
$x_5 = x_6 =$	$+ \frac{1}{3} C_3$	$+ \frac{1}{6} F$	$- \frac{1}{4} F$	$+ \frac{1}{24} F$
$x_7 = x_8 =$	$+ \frac{1}{3} C_4$	$- \frac{1}{24} F$	$- \frac{1}{24} F$	$- \frac{1}{24} F$
$x_9 =$	$+ \frac{1}{3} C_1$	$- \frac{1}{12} F$	$- \frac{1}{12} F$	$- \frac{1}{12} F$
$x_{10} =$	$+ \frac{1}{3} C_2$	$- \frac{1}{12} F$	$- \frac{1}{12} F$	$+ \frac{1}{12} F$
$x_{11} =$	$+ \frac{1}{3} C_3$	$- \frac{1}{12} F$	$+ \frac{1}{12} F$	$- \frac{1}{12} F$
$x_{12} =$	$+ \frac{1}{3} C_4$	$+ \frac{1}{12} F$	$+ \frac{1}{12} F$	$+ \frac{1}{12} F$

With regard to the side equation adjustment of the tetragon with an exterior pole, it is sufficient to state that the general rules already given apply equally well to this as to any other type of simple figure.

PRACTICAL APPLICATIONS

It is suggested that the inclusion of the type of figure under discussion into the list of simple figures capable of a semi-rigorous adjustment, much

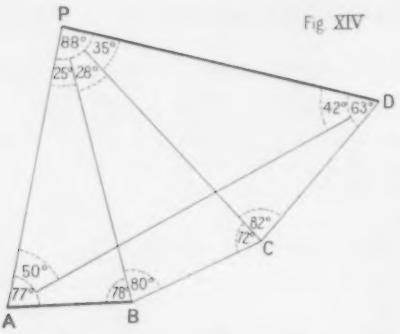


Fig. XIV

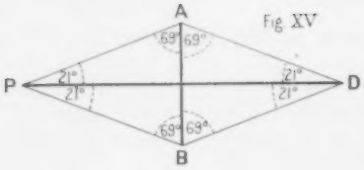


Fig. XV

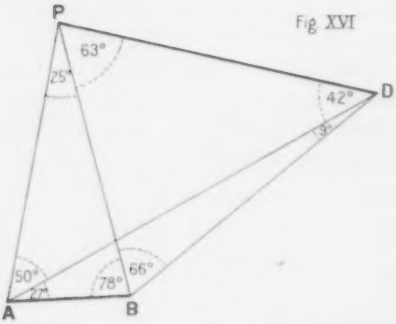


Fig. XVI

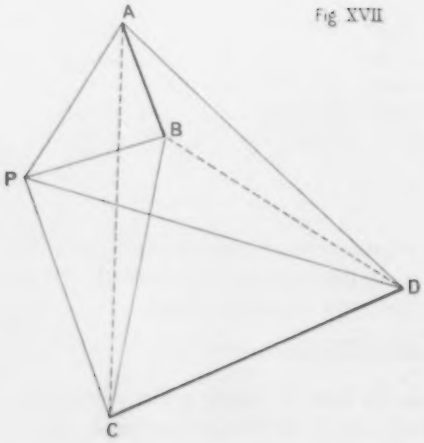


Fig. XVII

time, labor, and expense may be occasionally saved by its judicious use and that, furthermore, under certain circumstances its use might form the only practical solution to an otherwise intractable problem.

Example I (see Fig. XIV).—*AB* is a proposed base line, situated on the meander lobe of a flood plain. The river valley's general direction is at right angles to the base itself.

For the purpose of actual measurement the situation of *AB* is ideal, it being flat, even meadow land. However, there are difficulties in the way of extending the base to the main triangulation, as very few points on the surrounding upland can be seen from both ends of the base.

The point *P*, upstream from and therefore approximately at right angles to *AB*, is found to be a suitable station, but, owing to intervening low ground downstream, no such point can be chosen on the other side of the base to enable the extension to take the usual form of a closed quadrilateral.

A point, *C*, is found which can be seen from both ends of the base and also from *P*, but its position has obvious disadvantages, for if a closed quadrilateral is formed of the points *A*, *B*, *C*, and *P*, the angles *ACB* and *BAC* will be badly conditioned.

Another point, *D*, is found, but in this case, as its position is farther away from the edge of the valley, it and *B*, the nearest end of the base from it, are not mutually visible.

PD, however, would form a very desirable extension from the base, as it would fit in well with the main scheme of the triangulation. If the surveyor has directions to limit the scheme of triangulation to a network of simple independent figures, such as the quadrilateral and the central-pointed polygon, in this case he would be in a quandary and would probably have to discard the base *AB* for one not so suitable from a measurement point of view. However, the solution of the difficulty is simple and satisfactory if he decides to use all five points *A*, *B*, *C*, *D*, and *P* and make as his figure a tetragon with an exterior pole.

In this case *A*, *B*, *C*, and *D* are the four corners of the tetragon from which rays are drawn to the pole, *P*. From the way in which the triangles group themselves about the point *P*, it will be noticed that the figure is in Class 1. These four triangles are all comparatively well conditioned, the smallest angle, *APB*, being over 25° and the largest angle, *APD*, being under 90°. Now, the ratio of the base, *AB*, to the extension, *PD*, is approximately 3 to 8.

Example II (see Fig. XVII)—*AB* is the first extension of a small check base. It is desired to extend *AB* to *CD*, *C* and *D* being two stations in the main triangulation. Now, it is possible to connect up the points *A*, *B*, *C*, *D* in such a way as to form a central-pointed triangle with *B* as center; but, if this were done, most of the observed angles would be badly conditioned. Again, by choosing two more stations it would be possible to extend from *AB* to *CD* through two well conditioned quadrilaterals. This scheme, however, would greatly increase the field and computing work. A satisfactory compromise is therefore made by choosing a station, *P*, such as is visible to all the other stations *A*, *B*, *C*, and *D*. The stations are connected together, as shown in the figure, and again a "tetragon with an outside pole" is formed, this time belonging to Class 2.

RELATIVE WORTH

In order to arrive at some conclusion as to the relative worth of a tetragon with an outside pole, it would seem advisable to obtain a formula for expressing the weight of a simple figure.

Apart from the precision with which the angles have been measured, the relative weight of the finally adjusted side computed through a single chain of triangles in a triangulation net from a known base may be expressed by the formula[5]

$$w = \frac{3}{2^{n}} \cdot \frac{n \times nc}{(n-nc)^{n}} \cdot \frac{1}{\Sigma(\delta_A^2+\delta_A\delta_B+\delta_B^2)},$$

where n is the number of independently observed angles, n_c is the number of conditions that must be satisfied in the figure, and δ_A, δ_B are the differences of one second of arc in the log sines of the angles opposite the known side and the computed side in each triangle.

[5] The derivation of this formula is given in Appendix I.

Assuming that in a simple figure each "side" angle has been observed independently and that one of the "polar" angles is locally dependent on the others, then, where S equals the number of stations,[6]

$n = 3S - 4$

$n_c = S$.

Therefore, in the case of simple figures, the term

$$\frac{3}{2}\cdot\frac{n \times n_c}{(n - n_c)}$$

has values as shown in Table II.

TABLE II

(A) Number of Stations S	(B) $\frac{3}{2}\cdot\frac{n \times n_c}{(n - n_c)}$	Ratio $\frac{(B)}{(A)}$
4	12.00	3.00
5	13.75	2.75
6	15.75	2.625
7	17.85	2.55
8	20.00	2.50

The formula under discussion gives, however, only the weight of the finally computed side through a particular chain of triangles. What is wanted, in order to obtain the relative worth of different triangulation nets under similar conditions, is the weight of the net as a whole.

Obviously, it would not be correct to assume that this can be assessed simply by considering the best chain of triangles in each case, because theoretically the most probably correct determination of the finally computed side would be the weighted mean of all the results computed through each chain of triangles. Nevertheless, this statement assumes that the stronger the chain of triangles, the more influence it should have in determining the mean result. Consequently, in order to obtain the weight of the figure as a whole, rather than take the simple mean of the weights of each chain, the more correct procedure would be to take the weighted mean of these weights.

Therefore, if W is this weighted mean and if $w_1, w_2 \ldots\ldots w_n$ are the weights of the determinations computed through the individual chains of triangles,

then $W = \frac{\Sigma w^2}{\Sigma w}$.

Suppose these formulae for weight are used to compare Figure XIV, a tetragon with an outside pole, with Figures XV and XVI, the former being a quadrilateral whose diagonals bisect each other at right angles

[6] For proof of these equations see Appendix II.

and are in the same ratio as the base AB and the extension PD in Figure XIV, and the latter a quadrilateral formed of the stations A, B, P, D, in Figure XIV.

In Figure XIV there are two chains of triangles through which the length PD is computed from the length AB, and in each of the other figures there are four different ways of doing the same thing.

The results of these comparisons are shown in Table III.[7]

TABLE III

	Weight of Finally Computed Side Through Single Chain of Triangles		Weight of Figure $W = \frac{\Sigma w^2}{\Sigma w}$	Weight per Station of Figure $\frac{W}{S}$
Fig. XIV	w_1 =	5.50	4.85	0.97
	w_2 =	3.93		
Fig. XV	w_1 =	3.87	3.87	0.98
	w_2 =	3.87		
	w_3 =	3.87		
	w_4 =	3.87		
Fig. XVI	w_1 =	4.30	3.40	0.85
	w_2 =	3.43		
	w_3 =	1.00		
	w_4 =	0.56		

Again, as evidence of the comparative weakness of a simple figure with an exterior pole and composed of more than five stations (see p. 269) suppose Figure III and Figure IV are compared in the same way. In both figures the six stations are the same, and the finally computed side DE is found from the base AB. Figure III is a pentagon with an exterior pole, and there are two chains of triangles through which DE is computed. Figure IV is composed of two independent, but contiguous, closed quadrilaterals, and in this case there are sixteen chains of triangles.

The results of this comparison are shown in Table IV.

It must be remembered, of course, that any formula for weight is a relative one and should be used only to compare figures under similar conditions.

In conclusion, the writer gratefully acknowledges his indebtedness to Captain McCaw for suggesting the initial formula for determining the weight of the finally computed side through a single chain of triangles, and for other help in connection with the latter part of this paper.

[7] Note that in determining the results contained in Tables III and IV the unit for the values of the expression $\Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2)$ has been taken as one in the fifth place of logarithms.

TABLE IV

	$w_1 \quad w_2 \ldots\ldots w_n$		W	$\frac{W}{S}$
Fig. III	w_1 =	4.4	3.66	0.61
	w_2 =	2.1		
Fig. IV	w_1 =	10.0	6.13	1.02
	w_2 =	8.3		
	w_3 =	7.5		
	w_4 =	6.9		
	w_5 =	6.5		
	w_6 =	6.3		
	w_7 =	6.0		
	w_8 =	5.2		
	w_9 =	4.9		
	w_{10} =	3.6		
	w_{11} =	3.2		
	w_{12} =	3.2		
	w_{13} =	3.1		
	w_{14} =	3.0		
	w_{15} =	2.7		
	w_{16} =	2.1		

APPENDIX I

DERIVATION OF THE FORMULA FOR WEIGHT USED IN THIS PAPER

The formula

$$W = \frac{3}{2} \cdot \frac{n \times n_c}{(n - n_c)} \cdot \frac{1}{\Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2)}$$

is derived[1] from

$$\mu^2 \log a_n = \frac{2}{3}\mu'^2 \cdot \Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2),$$

where $\mu^2 \log a_n$ is the (m.s.e.)^2 of the log of the finally computed side, and

$$\mu' = \sqrt{\frac{n - n_c}{n}}, \mu_m$$

$$\mu_m = \frac{\mu}{\sqrt{p_m}}$$

$$\mu = \sqrt{\frac{\Sigma pv^2}{n_c}}$$

Substituting in these equations,

$$\mu^2 \log a_n = \frac{2}{3} \cdot \frac{(n - n_c)}{n \times n_c} \cdot \frac{\Sigma pv^2}{p_m} \cdot \Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2).$$

Assuming that the weight is inversely proportional to the square of the m.s.e., then, where w is the relative weight of a finally computed side from a known base through a given chain of triangles,

$$w = \frac{3}{2} \cdot \frac{n \times n_c}{n - n_c} \cdot \frac{p_m}{\Sigma pv^2} \cdot \frac{1}{\Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2)}.$$

[1] See Wright and Hayford, *op. cit.*, Section 174 (pp. 237–238).

Now, as the formula required is for the weight apart from the precision with which the observations have been made, the term $\frac{pm}{\Sigma pvv}$ should be discarded.

Then

$$w = \frac{3}{2} \cdot \frac{n \times n_c}{(n-n_c)} \cdot \frac{1}{\Sigma(\delta_A{}^2+\delta_A\delta_B+\delta_B{}^2)}.$$

The formula for the theoretical strength of a chain of triangles, as given by the U. S. Coast and Geodetic Survey,[9] is

$$R = \frac{n-n_c}{n} \cdot \Sigma(\delta_A{}^2 + \delta_A\delta_B + \delta_B{}^2),$$

where R is the reciprocal of the strength, and the unit for the values of the expression $(\delta_A{}^2 + \delta_A\delta_B + \delta_B{}^2)$ is one in the sixth place of logarithms.

It will be observed that this formula is derived from the same source as the one already employed and by comparison it will be found

$$\text{that } R = \frac{15n_c}{w}.$$

Therefore those who prefer to use the U. S. C. & G. S. formula and to think in terms of R may do so by dividing $15n_c$ or $15s$ by the values of the various w_1 and w_2 given in Tables III and IV, thereby obtaining corresponding values of R_1 and R_2.

Appendix II

Simple Figures: The Number of Independent Unknowns and Conditional Equations in a Simple Figure

In all simple figures, except the closed quadrilateral, one of the observation stations is taken as the pole.

Therefore, n = number of numbered angles − 1 (see p. 276)
= 3 (number of triangles in figure) — 1.

But number of triangles in figure $= S - 1$,

therefore, $n = 3(S - 1) - 1$
$= 3S - 4$.

In the case of the quadrilateral the same formula applies, as, obviously, if none of the observation stations is taken as the pole, then

$$n = 2S.$$

But in this case $S = 4$,

therefore $n = 3S - 4$.

When all lines (l) in a figure[10] have been observed over in both directions the number of side equations $= l - 2S + 3$. But in a simple figure this is always unity,

therefore, $l = 2(S - 1)$.

Now, total number of conditions $= 2l - 3S + 4$,

consequently, $n_c = 4(S - 1) - 3S + 4$
$= S$.

[9] General Instructions for the Field Work of the U. S. Coast and Geodetic Survey, *Special Publication No. 26*, Washington, D. C., 1915, Section 25 (p. 12).

[10] Wright and Hayford, *op. cit.*, Section 152 (pp. 202–203).

SWEDISH LATE-QUATERNARY GEOCHRONOLOGIES

By Ernst Antevs

The principal means employed for estimating the duration of the late-glacial and post-glacial epochs in Sweden are astronomical evidences; combination of astronomical evidences and immigration and migrations of plants and animals and arrangements of their associations; archeological evidences; changes of level; and annually laminated, or varved, late-glacial and post-glacial clays.[1] Of these the varved clays evidently are foremost, since they alone make an exact geochronology possible.

Andersson's and Munthe's Chronologies

Although now discarded, Andersson's and Munthe's estimates of the duration of the late-Quaternary time should be noted if only for historical reasons. They were based upon all the evidences mentioned above except the post-glacial clay.

Andersson[2] assumed that the maximum stage of the last glaciation coincided with a minimum of temperature which in Ekholm's[3] opinion existed during the last minimum inclination of the earth's axis to the ecliptic about 28,000 years ago. The ice retreat was supposed to have begun with the assumed temperature rise 26,000 years ago. The length of the post-glacial time was estimated at some 21,000 years.

Also Munthe was inclined to connect the maximum of the last glaciation with the supposed temperature minimum 28,000 years ago; and he assumed that the uncovering of Sweden began 24,000 years and the post-glacial epoch 17,600 years ago.[4]

De Geer's Late-Glacial Chronology

Using the seasonally banded, or varved, clays deposited in front of the receding ice borders De Geer worked out a chronology of the last ice reces-

[1] Late-glacial time according to the Swedish geochronology is the time from the beginning of waning of the last ice sheet to the bisection of the ice remnant, when the eastern ice edge stood at Stugun 38 kilometers (23½ miles) west of Ragunda (63° N.) in northern Sweden. Post-glacial time is the time after the bisection. The cutting through was accompanied by catastrophic drainage of the lake dammed on the west side of the ice and is thus recorded by a thick varve. For further information see, for instance, Ernst Antevs: On the Late-Glacial and Post-Glacial History of the Baltic, *Geogr. Rev.*, Vol. 12, 1922, pp. 602–612.

[2] Gunnar Andersson: The Climate of Sweden in the Late-Quaternary Period, *Sveriges Geol. Undersökning*, Ser. C, No. 218 (Arsbok 3, 1909, No. 1); reference on p. 39.

[3] Nils Ekholm: Om klimatets ändringar i geologisk och historisk tid samt deras orsaker, *Ymer*, Vol. 19, 1899, pp. 353–403.

Idem: On the Variations of the Climate of the Geological and Historical Past and Their Causes, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 27, 1901, pp. 1–62.

Cf. W. Köppen: Das System in den Bodenbewegungen und Klimawechseln des Quartärs im Ostseebecken, *Zeitschr. für Gletscherkunde*, Vol. 12, 1922, pp. 97–123; reference on pp. 118–122.

[4] Henrik Munthe: Studier öfver Gottlands senkvartära historia, *Sveriges Geol. Undersökning*, Ser. Ca., No. 4, 1910; reference on pp. 205 and 206.

Idem: Studies in the Late-Quaternary History of Southern Sweden, *Geol. Fören. Förhandl.*, Vol. 32, 1910, pp. 1197–1293; reference on pp. 1210–1213.

sion in Sweden.[5] Both the method and the history of the investigation are so well known that it is here sufficient merely to refer to De Geer's papers.[6] The method is the only accurate one there is. If clay exposures are frequent and contain great numbers of distinct and undisturbed varves, and if the work is carefully and critically carried out, the error may be brought down to less than one year in one hundred. However, De Geer's studies are not yet finished. The latest publication is a map in 1:10,000,000 with lines roughly indicating the positions of the ice front every 500 years. The ice retreat from the central parts of the Danish Islands up to Ragunda in Norrland (63° N.) is found to have taken about 5000 years. The time of the uncovering of Denmark and southwestern Scania, however, may be much underestimated.[7] During the last ten years De Geer has essentially presented preliminary reports on different detailed studies and on connections established over long distances.[8]

Lidén's Post-Glacial Chronology

Deposition of varved late-glacial clays evidently ceased when the ice sheet vanished; but their function as a register of years was continued without a break by a seasonally banded clay silt deposited in the fiords of northern Sweden. This clay silt, first studied by Lidén in the valley of the river Ångermanälven (63° N.), is thinly laminated on the whole, and the two zones representing the annual deposition show but slight difference in grain size and color.[9] The light-gray silt layer is deposited in the spring season when the rapid melting of the snow causes river floods. The fine-grained, clayey, dark-gray zone, the equivalent of the winter layer in the late-glacial clay, is formed during low water.

When the ice first withdrew from central Norrland that region stood as much as 280 meters (920 feet) lower than now in relation to the Baltic. In post-glacial time it has been subject to an uninterrupted rise down to the

[5] Gerard De Geer: A Thermographical Record of the Late-Quaternary Climate: Die Veränderungen des Klimas seit dem Maximum der letzten Eiszeit, Eine Sammlung von Berichten . . . herausgegeben von dem Exekutivkomitee des 11. Internatl. Geologenkongresses, Stockholm, 1910, pp. 303–310.

Idem: A Geochronology of the Last 12,000 Years, *Compte Rendu Congrès Géol. Internatl. XI, Stockholm, 1910*, Stockholm, 1912, pp. 241–253.

Idem: Om naturhistoriska kartor över den baltiska dalen, *Pop. Naturvet. Revy*, 1914, pp. 189–200, Stockholm.

[6] See also Ragnar Sandegren: Den kvartärgeologiska forskningen i Sverige under de senaste 25 åren, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 119–156.

Ernst Antevs: The Recession of the Last Ice Sheet in New England, *Amer. Geogr. Soc. Research Series No. 11*, 1922.

[7] Ernst Antevs: On the Pleistocene History of the Great Basin, in *Carnegie Instn. Publ. No. 352* (in press).

Idem: The Retreat of the Last Ice Sheet in Eastern Canada, *Geol. Survey of Canada Memoir* (in press).

[8] For Gerard De Geer's publications up to October, 1918, see Ebba Hult De Geer: Bibliographia De Geeriana, *Geol. Fören. Förhandl.*, Vol. 40, 1918, pp. 809–852.

Gerard De Geer: Geokronologiala relato inter la Alpala e la Skandinava glaciaci, *ibid.*, Vol. 41, 1919, pp. 227–233.

Idem: On the Determination of Geochronology by a Study of Laminated Deposits, *Science*, Vol. 52, (N. S.), 1920, pp. 502–503.

Idem: Correlation of Late-Glacial Clay Varves in North America with the Swedish Time Scale, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 70–73.

Idem: Nordamerikas kvartärgeologi belyst av den svenska tidskalan, *ibid.*, Vol. 43, 1921, pp. 497–499.

[9] Ragnar Lidén: Om issafsmältningen och den postglaciala landhöjningen i Ångermanland, *Geol. Fören. Förhandl.*, Vol. 33, 1911, pp. 271–280.

present. As a consequence the mouths of the rivers and the areas of sedimentation have gradually moved outwards, and the deposits have been raised above the water level and subsequently cut through by the rivers. So the deposits grow younger and younger, as we proceed downstream, and those of the last few hundred years are not yet raised above the level of the sea. The varved clay silts form the distal delta sediments and the most fine-grained part of the fiord deposits.

Because of this recession of the shore line, measurements have to be made from the surface downward and also down-valley. The number of varves deposited at a down-valley locality after the formation of the top varve at an up-valley locality gives the number of years required to shift the river mouth from the one point to the other. The difference in elevation between the planes of sedimentation gives the amount of land upheaval. The migration of the shore line and the sequence of strata show that the rise proceeded without interruption but at a progressively decreasing rate during the whole post-glacial epoch.

The retreat of the river mouth from the Baltic limit at an elevation of 238.5 meters (782 feet) down to Grillom, situated 21.5 meters (70.5 feet) above the present river mouth, was found to have taken 4520 years. From A. Bygdén's survey of the rise of the region during the last few centuries the upheaval of the last 21.5 meters is calculated to have taken 2040 years. The total length of the post-glacial period was thus found to be about 6560 years.

Continued field studies, finished some ten years ago, proved this figure to be too small. The material is not yet published, and to my knowledge no new figure has been publicly announced by Lidén himself. I have learned, probably through De Geer, that Lidén's final investigations give 8500 years as the duration of the post-glacial epoch in Sweden. Recently De Geer succeeded definitively in connecting Lidén's post-glacial time scale with that of the last ice retreat and so found the post-glacial time to amount to about 8800 years.[10]

Also in these new figures the time (some hundreds of years) that has elapsed since the deposition of the youngest raised and measured varve is only estimated. However, this gap might be bridged by the help of the climatic curve based upon the big trees (*Sequoia washingtoniana*) of California. It seems likely that the sequoia curve, based upon the thickness of the rings of growth, will show certain correspondence with the sedimentation curve in Norrland, which fairly accurately records the relative annual snowfall.[11] The climatic stress of the fourteenth century is distinctly

[10] Gerard De Geer: Om den definitiva förbindelsen mellan den svenska tidskalans senglaciala och postglaciala del, *Geol. Fören. Förhandl.*, Vol. 46, 1924, pp. 493–494.

Ragnar Sandegren: Ragundatraktens postglaciala utvecklingshistoria enligt den subfossila florans vittnesbörd, constituting Part III of "Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning," by H. W:son Ahlmann, C. C:son Caldenius, and Ragnar Sandegren, *Sveriges Geol. Undersökning*, Ser. Ca. No. 12, 1924, Stockholm; reference on p. 43. Reviewed in this number of the *Geographical Review*.

[11] Ernst Antevs: The Big Trees as a Climatic Measure, in *Carnegie Instn. Publ. No. 352* (in press). Also *Year Book Carnegie Instn. of Washington No. 22*, Washington, D. C., 1924, pp. 299–301.

recorded in the sequoia curve and is probably also marked in the clay deposits of Sweden, where the stress expressed itself in unusually cold winters, cold and rainy summers, and violent storms. If this proves to be the case, and if other marked fluctuations in the tree curves are found in the clay curve, a connection may be made with a high degree of probability, and the length of post-glacial time in Sweden exactly determined.

De Geer's Post-Glacial Chronology

When Lidén encountered difficulties in his studies in the valley of the Ångermanälven because of the constant outward shifting of the river mouth, De Geer conceived the idea that it might be easier to sum up the post-glacial varves deposited in a lake where all were accumulated in unbroken series from bottom to top.[12] Thus, in the fall of 1909 he studied the deposits of the ancient Lake Ragunda (63° N.) situated between Bispgården and Lake Gesunden in the valley of the Indalsälven River. Lake Ragunda had been dammed by an esker barrier across the ancient river channel and had its outlet over a rock ledge, but in 1796 it was catastrophically drained after the dam had been partly dug through. The lake deposits thereafter became deeply trenched by the stream. In the exposed sediments at Vidbäcken De Geer studied a section. He measured the varves in part of the profile, counted them in another part, and estimated them in the remaining uppermost part. He measured in all about 700 post-glacial varves and figured that the whole post-glacial sequence of annual layers amounted to about 7000. However, continued studies of Lake Ragunda carried out since 1911 by De Geer's pupils, Ahlmann, Caldenius, and Sandegren show that the deposits of the lake contain in all only about 3700 post-glacial varves and that the basin had become practically filled with sediments several thousand years ago.[13] Recently, as mentioned, De Geer using Lidén's investigations has made a new estimate of length of the post-glacial time.

Correlations

The Swedish late-Quaternary clay geochronologies are generally considered to be incompatible with all other late-Quaternary chronologies. It is true that they have considerably reduced the earlier estimates of the time elapsed since the uncovering of Sweden began,[14] but for the rest the view seems to be based upon hasty correlations. According to the best

[12] See footnote 5.

[13] Hans W: son Ahlmann, Carl C: zon Caldenius, and Ragnar Sandegren: The Qu ternary History of the Ragunda Region, Jämtland, *Geol. Fören. Förhandl.*, Vol. 34, 1912, pp. 343–364.

Idem: Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning, *Sveriges Geol. Undersökning*, Ser. Ca, No. 12, 1924.

[14] T. C. Chamberlin's statement (The Age of the Earth from the Geological Viewpoint, *Proc. Amer. Philos. Soc.*, Vol. 61, 1922, pp. 247–271; reference on p. 251) that De Geer's method tends to make the retreatal stage of the last glacial epoch *three times* as long as it was made by the most representative of the old estimates must be an error. Chamberlin must mean *one-third* as long.

American time estimates, viz. that by Taylor[15] based upon the recession of Niagara Falls and that by Coleman[16] founded upon the formation of the Iroquois beach, the abrasion of Scarborough Heights, the building of Toronto Island, etc., the uncovering of the Niagara Falls region from the ice took place some 20,000 to 30,000 or possibly 35,000 years ago and the release of Toronto 24,000 to 27,000 years ago, or both events in round figures 25,000 years ago.[17] About 10,000 to 11,000 years ago, under the assumption that the cutting of the whole Niagara gorge represents 25,000 years, the stage in the history of Lakes Superior, Michigan, and Huron called the Nipissing Great Lakes came into existence. It began as the ice edge retired from the Mattawa Valley and started to wane in earnest after having halted, readvanced, and receded slowly during the Kirkfield and Port Huron stages of Lake Algonquin and the cutting of the corresponding Old Narrow Gorge and Lower Great Gorge by the Niagara River, that is to say for between 10,000 and 15,000 years. This zone of retardation probably corresponds to a similar zone of stagnancy in the Danish Islands and southwestern Scania[18] which was followed by rapid ice retreat some 13,000 to 13,500 years ago according to clay-geochronological determinations. According to this correlation, which is the only one that with our present knowledge of the waning of the last ice sheets comes into consideration, the Swedish and the American time estimates differ but little.

[15] F. B. Taylor and E. M. Kindle: Niagara Folio, *U. S. Geol. Survey Geologic Atlas, Folio No. 190*, 1913. Cf. J. W. W. Spencer: The Falls of Niagara, *Geol. Survey of Canada Publ. No. 970*, Ottawa, 1907.

[16] A. P. Coleman: An Estimate of Post-Glacial and Inter-Glacial Time in North America, *Compte Rendu Congrès Géol. Internatl. XII, Canada, 1913*, Ottawa, 1914, pp. 435–449; reference on p. 442.

[17] A. P. Coleman: Glacial and Post-Glacial Lakes in Ontario, *Univ. of Toronto Studies, Biol. Ser. No. 21*, 1922; reference on p. 71.

[18] Ernst Antevs: The Retreat of the Last Ice Sheet in Eastern Canada, *Geol. Survey of Canada Memoir* (in press).

COMMERCIAL GEOGRAPHY AS A SCIENCE

REFLECTIONS ON SOME RECENT BOOKS*

By ISAIAH BOWMAN

The recent receipt of a number of books on related themes within the broad field of commerce naturally raises the general question. What is commercial geography? As a discipline it has swiftly displaced much of the physical geography of an earlier period. Its practical objectives have appealed to schools of commerce and to junior students searching for a means of making a living rather than a means of discovery or explanation. Its scientific value was much less seriously argued at first. Now we are in a new stage. Huntington and Williams open the preface to "Business Geography" with the dictum, "Modern geography has become a definite science." They continue: "Its principles are so well defined that a knowledge of the physical conditions under which a race has lived and now lives gives a reasonably reliable indication as to the capacity, activity, occupations, and business relations of that race." The style of the book carries one well along the road toward conviction that the authors have made out a case—but conviction does not quite arrive.

There is real scientific spirit in the introductory statement of Jones and Whittlesey: "Among the conditions which have bearing on economic activities . . . none is more fundamental than the natural environment, none changes so little from generation to generation, and none varies more from region to region." " . . . man may make and does make a choice as to

*R. H. Whitbeck and V. C. Finch: Economic Geography. 1st edit. x and 558 pp.; maps, diagrs., ills., index. McGraw-Hill Book Co., Inc., New York and London, 1924. 9½ x 6 inches.

Ellsworth Huntington and F. E. Williams: Business Geography. x and 482 pp.; maps, diagrs., ills. index. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1922. $2.75. 9 x 6 inches.

Ellsworth Huntington and S. W. Cushing: Modern Business Geography. viii and 352 pp. maps, diagrs., ills., bibliogr., index. World Book Co., Yonkers, N. Y. 1925. 9½ x 6½ inches.

W. D. Jones and D. S. Whittlesey: An Introduction to Economic Geography. Vol. 1 :The Natural Environment and Its Bearing on Economic Activities. Preprint No. 1, xiii and 3–38, 103–188 pp.; Preprint No. 2, viii and 39–68, 193–275 pp.; Preprint No. 3, vii and 69–91, 277–362 pp.; maps, diagrs., ills. University of Chicago, 1924. 9 x 6 inches.

W. D. Jones and D. S. Whittlesey: Suggestions to Teachers Using "An Introduction to Economic Geography." 9 pp. University of Chicago, 1924. 9 x 6 inches.

G. G. Chisholm: Handbook of Commercial Geography. New edit. xv and 824 pp.; maps, diagrs., index. Longmans, Green & Co., London, New York, Toronto, Bombay, Calcutta, and Madras, 1922. $7.50. 8½ x 6 inches.

G. G. Chisholm and J. H. Birrell: A Smaller Commercial Geography. New edit. xiv and 302 pp ; index. Longmans, Green & Co., London, New York, Toronto, Bombay, Calcutta, and Madras. 1923. 5s. 7½ x 5 inches.

E. G. R. Taylor: The Business Man's Geography. A Compendium of General and Post-War Conditions in Respect of Overseas Produce and Overseas Markets. 2nd edit. xvi and 496 pp.; maps, index. George Philip & Son, Ltd., London; Philip, Son & Nephew, Ltd., Liverpool, 1924,. 9 x 6 inches.

M. I. Newbigin: Commercial Geography. 256 pp.; index. (Home University Library). Henry Holt & Co., New York; Williams & Norgate, London, 1924. $1.00. 7 x 4¼ inches.

Clive Day: A History of Commerce. Revised and enlarged. x and 676 pp.; maps, bibliogrs., index. Longmans, Green & Co., New York, London, Toronto, Bombay, Calcutta, and Madras, 1923. $2.50. 8 x 5¼ inches.

A. L. Bishop: Outlines of American Foreign Commerce. vii and 321 pp.; bibliogr., index. Ginn & Co. Boston, New York, Chicago, London, Atlanta, Dallas, Columbus, San Francisco, 1923. $3.00. 8 x 5½ inches.

how his economic life is ordered." "The peculiar contribution of economic geography is an understanding of the relation between natural environment and economic life." Whitbeck and Finch have this to say: "Economic geography . . . endeavors to show the influences exerted by topography, climate, geographical position, and by soil and other natural resources upon the various types of activity by means of which man gains his living." They warn the reader that this is not all of commerce or business; and in the actual text, chapter by chapter, "geographical influence" is often lost in the mists of detail. We do not point this out by way of criticism; it is only the fact that we wish to note at this point. For "geographical influence" as a central all-embracing principle of geography is on the defensive. The number and variety of authentic illustrations of geographic factors in operation are increasing, one is tempted to say, almost in geometrical ratio, but so too is an appreciation of the truth that the *problem* is the thing, not this and that unrelated influence. The subject is still overloaded with absurd or trivial examples of alleged influence such as Congo dwarfs adapted in size to hunting in dense forest and jungle, or railroad tunnels through ridges instead of asking engines to follow the example of goats and mules. E. V. Robinson, as early as 1910, put the case fairly:

> . . . Those who have sought to rationalize the subject have as a rule proceeded on the assumption that everything must be explained, if it is to be explained at all, in terms of physical environment. The attempt, however, to explain the immensely complex distribution of industries by one set formula—the influence of environment—results in innumerable forced, artificial explanations which do not really explain. In the end, after the geographical factor has thus been seriously overworked, the usual upshot of the matter is a relapse into the old plan of piling fact upon fact, figure upon figure, without any serious attempt at explanation.[1]

Chisholm is content to give a list of subjects of which commercial geography treats, and he bases his work broadly upon commerce rather than upon the principle of "geographic control." This view of the subject is strikingly illustrated in the list of "subjects for research" given in his "Handbook" (pp. 22–23). He treats commerce as if it were a problem in and by itself, and he is not concerned with the boundaries of geography in relation thereto. For those who study commercial geography not for its philosophy but as a practical guide to business his method is certainly commendable; for those who plan to become professional geographers the superabundant facts appear to choke the philosophy. The philosophy is there—no doubt of that. It is sandwiched in everywhere, and very compact and very sound it appears. His "Goal of Commerce," the Herbertson Memorial Lecture for 1924,[2] is one of the ablest statements published in the field of commercial or economic geography. Chisholm is a scholar always. Evident also is the fact that his scholarship is in his head and not in his notes merely. His handbook, in its ninth edition after thirty-three years, is the mother of a widely scattered progeny.

[1] E. V. Robinson: Commercial Geography, Chicago and New York, 1910, p. vi.
[2] *Geogr. Teacher*, No. 69, Vol. 12, 1924, Summer, pp. 333-342.

Ubique, everywhere, appears to be the symbol of geography, taken literally; and thereto is added *everything*. Professor Davis insists on the question, Is it geographical? And Kipling writes, almost as if he had heard an echo of the annual discussion of Professor Davis' question at one of the December meetings of the Association of American Geographers:

> There's nothin' under 'eaven or 'ell Ubique doesn't mean.

To the question, Is it geographical? we may add another, Is it science? Perhaps a brief excursion is justifiable at this point. The search for truth is admittedly one of the greatest of the spiritual purposes of mankind. Yet "What is truth?" is no less debated now, with evolution a matter to be decided by legislative assemblies, than it was nineteen centuries ago. The aspiration to find out the truth of a thing may have nothing whatever to do with the result; but the spirit of investigation is a recognizable quality no matter what differences arise respecting the meaning of a thing when found. There is no such thing as a complete inventory of truth. There is no guidebook for this kind of journey. Peoples bred in different environments and inheriting different cultures or philosophies of life may look upon the world in quite different ways and have divergent standards of truth and purpose. Even in the United States there are strong and persistent regional differences respecting educational objectives in science no less than in the field of political policies. What a subject should be in content or style of treatment is not a matter of final and definite decision by a court of reference, especially if that subject deal with man, his ways and works.

We should probably all agree that one of the objectives of commercial geography is to aid in helping man measurably to command the earth instead of being commanded by her. And by "being commanded" we mean influenced and not necessarily controlled. We should like to have the subject become an agency of power and thus help man to extend his dominion over nature. If "man is the measure of his own universe" then commercial geography, of all branches of the science, ought to afford him direct and immediate help. It ought to enable him to extend his occupation of the land out into the difficult pioneer belts where the margin of safety is small; "to interpret the earth in terms of its usefulness to humanity," as J. Russell Smith sets the problem in "Industrial and Commercial Geography." It ought to tell him where he is inefficient and how better to use and possess this earth of his. For example, shall a crop like alfalfa be cut and cured green by artificial means or dried wastefully by sun and wind? If it is possible by the former means to increase the food supply three or four times, shall agriculture struggle along as now or shall it to a large degree adopt new means and defeat some of the enslaving forces of nature? Just to know the facts of his world is not enough. Biologically man is crowding the planet. Is his research in commercial geography also dealing with the fringe of facts? Is it seeking new truth?

The Measure of a Science

To be a science commercial geography ought by definition to fulfill three conditions: it should (1) have its facts arranged in a systematic order; (2) rationally explain present conditions in accordance with established "laws"; (3) predict the future course of development or lead the way to the discovery of new laws. These it should do not in any absolute or infallible sense but with some degree of accuracy. The tests applied by one person in a given solution must be capable of verification at other places and by other men under standard conditions, just as a physicist or a physiologist lays down the governing conditions of his experiment and confidently invites verification of a truth or law which he claims to have discovered. The terms of discussion are in the main specific, not general, and every step in a proof must rest upon facts and a logical progression of argument.

If we apply these tests to commercial geography the subject appears to be far from being a science; and there are, moreover, but few indications of its so becoming. There is, however, one commendable example of its progress in this direction which is at once so striking and convincing in character that it deserves special recognition. If a substantial part of commercial geography rested upon problems solved with this degree of exactness its status as a science would be beyond question. The example in point is embodied in a paper by J. F. Unstead entitled "The Climatic Limits of Wheat Cultivation, with Special Reference to North America."[3] The main argument runs as follows. The existing limits of wheat cultivation are rarely set by physical controls but rather by economic factors such as facilities for transport and the supply of labor. Furthermore, the ultimate limits cannot now be estimated in a final manner, for man himself may alter the range of cultivation by increasing his knowledge of seed, soil, and agricultural operations. These things eliminated, Unstead proceeds to the setting of limits under existing conditions and draws his limiting line upon a map. His argument of 20,000 words or more cannot be repeated here, but among his conclusions are the following (the italics being ours):

> . . . *Wheat cultivation is possible* at stations where the degrees of accumulated temperature, which is experienced between the dates when the mean temperature curve rises above 5° C. in spring and descends to 10° C. in autumn, amount to the number indicated by the straight line in Fig. 3 as that required under the conditions of mean temperature and duration of light during the same period at the respective stations.[4]

He then goes on to say significantly:

> This conclusion may be *tested* by . . .

Further on he adds:

> . . . With the adoption of suitable methods of cultivation, including summer-fallowing and the use of drought-resistant varieties, wheat cultivation *will be possible* over the whole of the semi-arid region of southern Alberta and Saskatchewan.[5]

[3] *Geogr. Journ.*, Vol. 39, 1912, pp. 347–366 and 421–446.
[4] *Loc. cit.*, p. 359.
[5] *Ibid.*, p. 435.

Put beside the commercial geographies a text like Davis' "Physical Geography," and the difference between a book loaded with inappropriate descriptive detail and a book worked out step by step as a science is all too apparent. Happily, the present may be a passing stage in the development of commercial geography. It may be that the rapid organization of the data of the subject will be followed shortly by a new organization of principles or laws. The problem seems to be to get past the stage of propaganda. Each author writes as if he had to make out a case for his subject as science or for a given detail as geographical. Even the boundaries of the subject (according to some) seem to be in perpetual need of defense, like all pioneer enterprises on the border of the wilderness. This tempts an author to protest too much and too often. By contrast, a physicist goes directly to his point, neither trying to prove that it is science nor seeming to care whether or not you call it physics. To him, as it should be to us, the problem is the thing, and the subject of boundaries is academic.

In *Nature* for January 17, 1925, there is a thoughtful review of Brunhes' "Human Geography." It ends on a note of the deepest importance in the consideration of any part of geography as a science.

> Whither does all this lead? Apparently to the notion that geography is not a science, not an ordered body of knowledge, which is independent of the personality of the investigator, not a set of conclusions which must be universally valid, not a statement of generalisations valid for all time or for every place, but primarily and fundamentally a discipline, an outlook on man's life on the earth, which gives to the thinker that unique geographic sense so invaluable for the law-maker, the captain of industry, and the merchant prince, so useful a corrective in all matters which pertain to the conduct of human affairs on the large scale.
>
> Whatever view may be taken, it must be confessed that the facts of geography are stubborn; they cannot be melted in the mental furnace and run into set moulds; they frequently misfit the theories: but the spirit of geography is of unique value. No other human study permeates so many of the sciences: no other study is so necessary to the equipment of the educated man.[6]

Perhaps enough has been said to show that there are two distinct groups of data in commercial geography: (1) a group of facts capable of rather rigid scientific treatment; (2) a group of facts so related to the changing spirit of man and his inventions that less importance should be attached to the mode of treatment than to the geographical point of view. The indulgence of the reader is asked while we gently insist on the point that commercial geography cannot be treated *throughout* like mechanics or light or chemical elements.

The Potato: A Homely Example

Granted all this, geography still remains in a state of thralldom. Tradition hems it about. It is in science what the division Vermes long was in biology—a wastebasket. When you didn't know what to call a thing, you called it a worm! It is a grave question in education as in research how to

[6] *Nature*, No. 2881, Vol. 115, 1925, Jan. 17, p. 76.

take off the overload of irrelevant detail of an encyclopedic nature. Take potatoes as a homely example. One author says: "The states of Minnesota, New York, Michigan, Wisconsin, Pennsylvania, and Maine are the greatest potato producers. Certain parts of those states, where the climate is cool and moist and the soil sandy, are especially adapted to potatoes . . . Aroostook County in the northern part of Maine is by far the best potato region in the whole United States." Is it due to climate or soil? If the author knew how potato culture is organized in Maine he would have said much on that score and less about climate and soil. In Aroostook County potato culture is almost a disease!

The fact is that in many parts of the United States potatoes are a crop of the first importance where the soil is not sandy. A clay loam with an exceptional admixture of humus is also "especially adapted to potatoes." Why do potatoes from sandy soils form an important basis of commerce? The author does not say. The fact is also that a cool climate is not essential. The potato originated in the high and distinctly dry regions of the Central Andes and has quite remarkable powers of adaptation to climate, being cultivated in the tropics as well as in high latitudes, "even beyond the polar limit of barley." Whitbeck and Finch (pp. 54–56) get at the heart of the problem in a few words though one could wish a better statement of soil requirements or importance.

Taking the texts one after another, and the staples one by one, and the same criticisms may be made in the majority of cases that have been made in the case of potatoes. The most important exception among all the authors is Chisholm. No one else has so controlled his discussion with facts. Being a superlatively modest scholar he says little in the way of criticism of the carelessness of other authors in his field. But he must have lots of fun reading them! Is there a geography of potatoes that is capable of scientific treatment? O. E. Baker could write about it and explain things and predict. Why does a "sandy soil" get all this favoritism? Will the top soil of a cool, sandy beach in "a moist climate" grow an abundant crop of potatoes? There's a deal of science here that the texts do not take into account though the authors make room for much interesting though irrelevant detail.

Not reasoned explanation but easy appeal to soil, climate, and relief is the rule. "The limiting factor in the agricultural development of Argentina is rainfall." Such a statement raises more questions than it answers. Is it good science to leave it as the introductory sentence of a regional description? It reminds one of a recent contributor to *Science* who stated that a certain region had an "Arctic climate." How would one define that kind of a climate? How would one use the alleged fact in an ordered argument? *What does it mean?* More naive is the following: "If a farmer cannot sell his potatoes or milk, he at least has something on which he and his family can live. But if the manufacturer of screws cannot sell his product at a price sufficient to pay for the cost of manufacture, he and his employees

have no means of getting a living." This is not like art—a thing that must be felt to be understood; it can be thought out. The leading hardware company of St. Louis knows better. Take the simplest of three or four main aspects of such a problem. If it be replied that to "getting a living" is added "in the long run" (understood), then how will the farmer clothe his family in the long run? How does *any* manufacturer determine the scale of his production? Does he live by salesmanship alone? The fact is that his decision rests in part on something very definite.

What is authentic and what is apocryphal, only the ripening influence of time will show. Commercial geography, like geography in general, as a subject, has a cultural and also a practical value to living men that far transcends its purely scientific content. But when we *claim* a definite scientific character for the subject as now developed, are we not claiming too much? The science in it is still far too feeble and juvenile, the purely descriptive portions too encyclopedic and irrelevant. The books are full of the data of commerce; there is needed a Davis or a Vidal la Blache to give the data scientific organization.

Whitbeck and Finch's "Economic Geography"

Half of this book is devoted to the United States and Canada, and the remaining half takes up the several states of principal commercial importance in the world. The leading American text in which economic theory and the problems of transportation are interwoven with the facts of physical environment has been Smith's "Industrial and Commercial Geography" first published in 1913. Whitbeck and Finch now share the position. Admirable is their close organization of the facts of commerce and the brief and sound explanations of the tendencies of commerce in a given physical framework. The argument runs less securely in foreign fields. In the case of The Netherlands, for example, we discover in the last paragraph that "the Dutch are inherently a commercial and seafaring people, as centuries of their history have shown . . "; but the development of the idea, that is, the effect of seafaring life and its full meaning in The Netherlands today, are not brought out in the remaining twelve lines of the paragraph. It would seem as if this theme should be the dominant one in the section and overshadow in intensity of treatment the purely descriptive portions. The text is a substantial contribution to the literature of commercial geography, and it deserves consideration among the first class of books in its field.

Huntington and Williams' "Business Geography" and Huntington and Cushing's "Modern Business Geography"

In both of these texts, the one advanced, the other elementary—there are two features of which special mention should be made, the attractive style in which they are written and the attention given, especially in the

elementary book, to the exercises and problems that follow each chapter. The weakness of the books lies in the field in which Whitbeck and Finch are strong: there is no proper basis of economic theory, and the explanations are far from being secure. The problems of today are cleverly pointed out, and the point of view is one which will stimulate the student to fresh and original investigation. So far as the writer of this article is aware, no book now in the market save Jones and Whittlesey (see below), gives so much attention to the solving of problems by the student himself. An important pedagogical principle is illustrated by the two books: in the case of the advanced book the technical typographical treatment is uninviting, whereas in the case of "Modern Business Geography" every device of typographical display and of illustration has been worked out in a most attractive manner.

Jones and Whittlesey's "Introduction to Economic Geography"

From the standpoint of practical work on the part of the student these volumes deserve a leading place. The scheme of organization is novel. Each of the three books consists of three parts. Part I deals with exercises. Part II deals with textual materials built up partly by contributions from the authors themselves but in greater part by exceedingly well selected quotations from geographical literature so cleverly arranged that there is a progression and unity of purpose which other authors achieve by a text in which all of the material is newly reworked. Part III consists of illustrations, diagrams, graphs, photographs, maps, charts, and the like. The questions in Part I are arranged in systematic order as if the whole were a text of the ordinary kind. The value of the books lies in the ingenuity and skill and particularly in the sound judgment which have been expended in the framing and arrangement of the questions. No commonplace or haphazard scheme of treatment has been adopted, but rather a scientific use of the method of inquiry. Next to a first-class text in which all the material is thoroughly reworked and given unity of scientific treatment and a rigidly close organization of both principles and facts is the method adopted by these authors, who depend upon original descriptions, photographs, and maps for the integrity of the successive lessons. Having said this much in praise of the excellent organization of the material perhaps a word of criticism may be permitted and it can be put in the form of a conundrum: Q. When is a map not a map? A. When it has neither scale nor coördinates.

Chisholm's "Handbook of Commercial Geography"

We have already commented on the number of excellent features in Chisholm's handbook. It only remains to say that the author has spared neither expense nor effort to bring his text up to date. Published in 1922, its maps do not always display the existing boundaries. The present eastern boundary of Greece does not appear on the general map of Europe, and the Smyrna district of late Greek occupation is no longer valid. These

are mentioned only to illustrate the difficulties which any text published since the war has had to face on account of changing boundaries, a difficulty of the history texts as well as those in geography. In the organization of the material under each political unit the author has included the outstanding facts of political condition, new grouping of resources, and the shifting of emphasis to accord with the economic conditions set up in the new or greatly modified states of Central Europe. The reference value of the work is greatly enhanced by the inclusion in the appendix of a large variety of statistical material relating to trade and by a list of alternative geographical names, of special value at this time in view of the changes brought about by nationalistic sentiment.

Chisholm and Birrell's "Smaller Commercial Geography"

But little need be said of the smaller edition of Chisholm's work prepared by Mr. Birrell. The smaller book gives no space to what may be called the philosophy of the subject; it consists almost entirely of statements of fact. Commercial geography is defined as consisting of certain "subjects." The facts given are those relating to commerce alone and are arranged according to regional categories save for a few introductory explanations. The method seems to be non-applicable to American conditions of education, and the matter itself seems to have been prepared for the purpose of special examinations; but, of course, this is conjecture.

Taylor's "Business Man's Geography"

The object of this book seems to be purely practical, that is to make it a work of reference merely rather than a work of science. Its title is its whole explanation. The matter is arranged in alphabetical order throughout: the first page treats of Abyssinia, and the last topic on the final page is Zululand. The treatment of facts under the several headings is purely informational or encyclopedic. The maps are bold and coarsely drawn for reproduction on rough paper; and, though their appearance is in general not pleasing, a number of them are cleverly conceived. Particular mention should be made of the excellence of Figure 52, showing the manufactures and communications of Czechoslovakia (which should really read Bohemia in this instance).

Newbigin's "Commercial Geography"

For its length Miss Newbigin's book contains far more discussion of principles and causes than any of the other books of the series. Details are subordinated to their proper place as illustrations of a principle or a relationship, and broad knowledge and excellent judgment are among the elements that go to constitute a book exhibiting real craftsmanship. Perhaps these good qualities have been achieved because the book falls in a special series

of elementary books on substantial themes worked out for the mature reader rather than for formal classroom purposes. Whatever the reason, the result is unquestionably a book of high grade. In comparison with the other texts and for educational purposes the book suffers because of the lack of any illustrations whatever, either in the way of maps or photographs, since these fall outside the scope of the series in which the book has a place.

Day's "History of Commerce"

We have thrown into the references at the beginning of this article two books that are not commercial geography by intention, and the preliminary discussion of commercial geography as a science is therefore to be understood as having no application to these texts. It is rather for the purpose of bringing them to the attention of American geographers that they are included here. Professor Day's book has been revised several times since its original publication in 1907, and the latest revision has brought the "History of Commerce" down through the war years and the "two or three years of peace immediately following." The text has been reworked several times, and it now exhibits a high degree of organization. It is of particular value to students of commerce because the author, not a geographer, has taken into account every sort of factor that he deems important in the development of commerce, whether it relates to public finance, currency, foreign exchange, or the general trends and conditions of international trade. The chapters on exploration and discovery, roads and railroads, and navigation convey an unusual amount of geographical information. Were some of the data of this book and also its explanations of the development of present conditions to be combined with the geographical philosophy and treatment of Whitbeck and Finch, or Chisholm, or Newbigin, it would seem as if the result would be far ahead of even the best of the commercial geographies now in the field.

Bishop's "Outlines of American Foreign Commerce"

There is here a steady flow of statements of fact, and the arrangement is logical throughout. The book proceeds from natural resources and industries to the export and import trade of the country and related problems of insurance, financing, and promotion. The usefulness of the book as a work of reference to commercial geographers is worth emphasizing, though there seems to be little real attention to the explanations of things but rather a statement of the order of events despite the first sentence of the preface, which states that the intention is to develop the subject "in the light of the fundamental principles upon which trade is based." Immediate or proximate "causes" are discussed rather than principles.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of January and February. The annual meeting of the American Geographical Society was held on January 20, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After the reading of the annual reports and the election of officers for 1925 the Society was addressed by Mr. Merian C. Cooper on "The Migrations of the Bakhtiari." Both films and still pictures were of extraordinary geographical interest. They depicted the life of a nomadic people during their eastward migration from the plains of Arabistan, north of the Persian Gulf, to the Plateau of Ispahan in Western Persia, a journey of forty-six days which involves the crossing of the deep Karun River and the rugged Bakhtiari Mountains.

At the regular monthly meeting of February 24 an illustrated lecture of unusual scientific interest was given by Dr. Philip S. Smith of the U. S. Geological Survey, on "Exploring in Northern Alaska." An article on this subject appears in this number of the *Review*. The field of Dr. Smith's latest work includes the Naval Petroleum Reserve, parts of which have not been explored hitherto.

Elections to Fellowship. At the January meeting of the Society, President Greenough presiding, and the February meeting, President Finley presiding, there were presented with the approval of the Council the names of 229 candidates who were duly elected as Fellows.

Resolution in Honor of President Greenough. At the February meeting of the Council the following resolution was adopted in view of Mr. Greenough's election as Honorary President of the Society. It was read to the Fellows of the Society at the regular monthly meeting on February 24.

RESOLVED that the following minute be entered upon the record:

Mr. Greenough became a Fellow of the Society in 1883 and a member of the Council in January, 1900. Besides serving on various committees of the Society he was Chairman of the Council from March, 1906, to February, 1907, and February, 1913, to February, 1921; and Vice-President from January, 1908, to January, 1916. In 1916 he was elected President of the Society and in that capacity has served for nine years. In that period there took place many changes in the administration of the Society's professional work. It was he who first proposed the appointment of a professional geographer as Director of the Society. Through an extension of the functions of the several committees, such as the Publication Committee, the Committee on Exploration and Research, the Committee on Medal Awards, and a number of other special committees all of which were appointed at his suggestion, the Council was brought into much more active relation to the work of the several departments than at any previous time. The result of these steps has been greatly to extend the area of general interest in the work of the Society and to bring about a great advance particularly in its publications.

He has presided at the regular meetings of the Society with a fidelity unsurpassed in its history and, like Judge Daly, has left a permanent impression upon the membership of the Society by reason of his unfailing attention to its business. In a period of fourteen years he was absent but once from his place as Chairman at the regular monthly meetings of the Council and Fellows.

In recognition of his service to the Society and as a mark of respect, his colleagues on the Council have unanimously adopted this resolution and directed that the same be read at the next regular monthly meeting of the Council and Fellows.

Annual Reports of the Society. At the annual meeting of the American Geographical Society, held on January 21 at the Engineering Societies' Building, 29 West Thirty-ninth Street, the annual reports of the Council, of the Treasurer, and of the Special Committee were read as follows:

Report of the Council

New York, January 15, 1925

To the Fellows of the Society:

In our review of the Society's activities for 1925 a place of importance must needs be given to the *Geographical Review*, the quarterly journal of the Society. Each number contains a quantity of scholarly material as great as that found in a book of substantial size, and no less impressive than the amount of it is its extraordinary variety and interest. The thirty-eight principal articles in addition to the seventy-eight notes and sixty-eight reviews published in 1924 deal with leading problems in every branch of geographical science: they are not casual or temporary in nature; we aim to make them permanent contributions to knowledge. The maps which illustrate the several articles are drawn so far as possible from new and original sources and, drawn with high professional skill and accuracy, they have contributed to make the *Geographical Review* one of the leading scientific journals in the world today.

Though the Society has concentrated its research work to a large degree in the field of Hispanic American maps, it has by no means confined itself to that field. It has also supported in one form or another studies in the soils and vegetation of Africa, in historical geography, colonization, population distributions in many lands, in political geography in the problem areas of the world, as well as substantial enterprises in the United States. The Society's point of view with reference to specific projects of publication, field work, and research is that it should undertake to do those things which contribute to the general good of geographical science and professional geographers of every class and which the individual geographer could not do, working as he must, single-handed, and with very limited funds. The Millionth Map of Hispanic America has made excellent progress. The compilation and drawing of new sheets go forward steadily, and the coöperation of various societies, bureaus, and governments in the southern countries has been secured. The governments of Panama, Ecuador, Bolivia, Peru, Chile, and Salvador have taken an especially active part during 1924 in advancing the purposes of the program. Related publications, such as the map catalogue in process of compilation, and the regional and population studies referred to in earlier reports, are in a state of healthy progress.

The books and maps published by the Society during the past year include the following:

1. The Geographical Conceptions of Columbus: A Critical Consideration of Four Problems. By George E. Nunn.

(A new and original statement of problems to be solved, and established conclusions to be reconsidered.)

2. Geographical Lore of the Time of the Crusades. By J. K. Wright.

(A study in the history of geography illustrating the origins and condition of geographical knowledge and tradition in Western Europe.)

3. Desert Trails of Atacama. By Isaiah Bowman.

(A study of desert and high mountain and plateau settlements in the Atacama region of northern Chile and northwestern Argentina.)

4. GEOGRAPHY IN FRANCE. By Emmanuel de Martonne.

(A history of the development and present status of geography in France by one of its leading exponents.)

5. EARLY TOPOGRAPHICAL MAPS. By J. K. Wright.

(Their Geographical and Historical Value as Illustrated by the Maps of the Harrison Collection of the American Geographical Society.)

6. MAP OF HISPANIC AMERICA, 1:1,000,000 (15.78 to 1 inch). Sheets South C-19, Acre, and North 9-12, Baja California-Sur.

7. MAP OF THE MOHAMMEDAN WORLD.

(Accompanies "The Mohammedan World," by Isaiah Bowman, *Geogr. Rev.*, Vol. 14, 1924, pp. 62-74. Shows population distribution, rainfall, interior basin drainage, railways, etc.)

8. MAP OF SAN JUANCITO MOUNTAINS, HONDURAS. By Joseph H. Sinclair. Scale 1:150,000.

9. TRIANGULATION OF AN AREA IN SOUTHERN HONDURAS. By Joseph H. Sinclair. Scale 1:1,250,000.

(Accompany "Notes on the Mapping of an Area in Southern Honduras," by Joseph H. Sinclair, *Geogr. Rev.*, Vol. 14, 1924, pp. 275-281.)

10. PROVINCE OF ESMERALDAS, NORTHWESTERN ECUADOR. Scale 1:1,280,000.

(Accompanies "Geographical Notes on Esmeraldas, Northwestern Ecuador," by Carlos M. Larrea, *Geogr. Rev.*, Vol. 14, 1924, pp. 373-387.)

Among the publication projects for 1925 there are two that are especially noteworthy:

BIBLIOGRAPHIE GÉOGRAPHIQUE

By a coöperative arrangement with the *Association de Géographes Français* the Society participates in the preparation of material and the publication of this scholarly bibliography in order to make a contribution to the facilities for research in the United States. The first number to contain material contributed by the Society is Volume 33, dealing with publications for 1923. It is now in process of distribution by the Society.

ARABIAN GEOGRAPHY AND HISTORY

Through the interest and generosity of Charles R. Crane, Esq., the Society is enabled to edit, publish, and distribute the results of thirty years' study of Arabian geography and history on the part of Professor Musil, of which fourteen years were spent in the field. The work will be produced in six volumes and will be illustrated by photographs and diagrams. It will deal with the Northern Hejaz, Arabia Deserta, Palmyrena, the Middle Euphrates, the Northern Neged, and the Manners and Customs of the Rwala Bedouins.

Passing to one of our newer activities, the Society's School of Surveying, it may be noted that the equipment has been completed, the course of study arranged, and instruction has begun. There is now available in this country a place where first-class modern training in field methods especially applicable to geographical science can be provided.

During 1924 the Society awarded three gold medals as follows:

Charles P. Daly Medal to Colonel Claude H. Birdseye, Chief Topographic Engineer of the U. S. Geological Survey. (See *Geogr. Rev.*, Vol. 14, 1924, pp. 465-466.)

Cullum Geographical Medal to Professor Jovan Cvijić of the University of Belgrade. (See *Geogr. Rev.*, Vol. 14, 1924, p. 466, and Vol. 15, 1925, pp. 131.)

David Livingstone Centenary Medal to Commander Frank Wild of the expeditions of Scott, Mawson, and Shackleton. (See *Geogr. Rev.*, Vol. 14, 1924, p. 466.)

The Society has also elected the following to honorary Corresponding Membership: Edwin R. Heath, H. L. Shantz, Paul Le Cointe, Lauge Koch, and Byron Khun de Prorok.

Following precedent the Society has sent representatives to important scientific gatherings and occasions of special geographical interest: Section E, Geography, British Association for the Advancement of Science, Toronto; and the Third Pan-American Scientific Congress, Lima, Peru.

Additions to the library during the year comprise 795 books, 708 pamphlets, 6250 new issues of periodicals, 3015 maps, 73 atlases. The collection now numbers 65,448 volumes of books and pamphlets and 64,085 atlases and maps. Among the conspicuous gifts to the library from generous friends of the Society have been the following:

Crown Collection of Maps, from James B. Ford, Esq.

Cassini Map of France, from the Honorable Francis Burton Harrison.

Collection of Colored Lantern Slides, from Mrs. George Kennan.

The lectures of the Society have been unusually well attended. The speakers have been as follows:

Sir Percy Sykes, "The Heart of Asia and the Roof of the World;" Horace D. Ashton, "A Caravan Journey into the Northern Sahara;" Poultney Bigelow, "The Colonies of Japan;" Colonel Claude H. Birdseye, "Boating in the Grand Canyon;" Count Byron Khun de Prorok, "Ancient Carthage and the Dead Cities of the Sahara;" Dr. Lauge Koch, "Explorations in Northernmost Greenland."

The number of Fellows at the close of the year was 4062, of whom 395 are Life Fellows. In addition there are 12 Honorary and 39 Corresponding Members.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1924

Receipts and Expenses

During the year there have been received from annual dues, interest on investments, and sales of publications	$68,396.26
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	78,293.17
Balance charged against Special Deposit Fund	$9,896.91

Condensed Balance Sheet, December 31, 1924

Cash	$10,842.92
Sundry balances and investments	98,976.89
Inventory of publications	7,798.03
	$117,617.84

Capital Account, Balance uninvested	$91.42
Annual dues paid in advance	2,232.33
Special Fund for general purposes	80,562.45
Sundry deposits and reserves	24,443.74
Hispanic-American Research Fund, Balance	10,287.90
	$117,617.84

HENRY PARISH
Treasurer

REPORT OF SPECIAL COMMITTEE

New York, January 15, 1925

The Committee appointed at the meeting of the Council held on December 18, 1924, to nominate officers for the vacancies to occur in the Council in January, 1925, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 20, 1925:

		Term to expire in
Honorary President	John Greenough	
President	John H. Finley	January, 1926
Vice-President	James B. Ford	January, 1928
Recording Secretary	Hamilton Fish Kean	January, 1928
Treasurer	Henry Parish	January, 1928
Councilors	Philip A. Carroll Archer M. Huntington Charles A. Peabody Frederick C. Walcott	January, 1928

Hamilton Fish Kean
James B. Ford
Archer M. Huntington
Committee

GEOGRAPHICAL RECORD

NORTH AMERICA

Notes on the Arctic Coast of Canada. The existence of copper-bearing deposits on the Arctic coasts and islands of Canada has been known since the eighteenth century when Samuel Hearne made his famous journey northward to the Coppermine River in 1771 in search of a mine reported by the Indians. Since Hearne's time the few travelers who have visited these remote wilds have brought back meager reports of copper ore and of native copper at the mouth of the Coppermine and at various other points—Bathurst Inlet, Boothia Peninsula, Princess Royal Island, and the interior of Victoria Island. Definite information, however, is available only concerning the deposits of the Coppermine River and Bathurst Inlet, the others being known but vaguely through the testimony of Eskimos and other untrained observers. The latest and most detailed data on the Coppermine River and Bathurst Inlet deposits and upon the geology and geography of the neighboring country will be found, together with a geological and topographical map of the coast from Darnley Bay to Bathurst Inlet (1:633,600), in the *Report of the Canadian Arctic Expedition 1913–18, Southern Party*, Vol. 11: Geology and Geography; Part A, The Geology of the Arctic Coast of Canada, West of the Kent Peninsula, by J. J. O'Neill; Part B, Geographical Notes on the Arctic Coast of Canada, by Kenneth G. Chipman and John R. Cox; Ottawa, 1924.

The Bathurst Inlet deposits lie more than 150 miles east of the mouth of the Coppermine. Mr. O'Neill writes that they "probably form an important reserve of copper ore" but that this reserve "is not sufficiently attractive under present conditions of accessibility, transportation, demand, etc., to warrant the large expense necessary to prove and develop the deposits." Conditions on the Coppermine are more favorable: "It seems highly probable that parts of this district contain workable and even rich deposits." The problem of accessibility is not as serious here, for "the district is easily reached from Great Bear lake, and transportation could be arranged *via* the Mackenzie river valley."

The climate of these regions does not seem to be prohibitive to settlement. At Dolphin and Union Strait, where the members of the expedition wintered, the mean temperature of the months from November to March inclusive in 1914–1915 and in 1915–1916 was −15° F., with minima of −49° and −45°. The snowfall is light, not exceeding two feet, and for three or four months during the summer the ground is usually bare. The mean temperature of the summer months, June–September, is over 32° F. Yet, although the winter temperatures are not terrifically low, "a penetrating wind blows almost continuously. We have seen dogs from the interior, accustomed to a dry windless temperature of 60 to 70 degrees below zero, that were miserably cold in zero weather on the coast." Instrumental observations were found to be attended with peculiar difficulties at low temperatures, as a result of the thickening of lubricating oil, the freezing of the observer's fingers, and the freezing and fogging of lenses. Methods for overcoming these difficulties are suggested in Chipman and Cox's paper.

The country along the coast is a bleak tundra, or "barren ground," although willows are found by some of the streams, and "twenty miles up the Coppermine there is plenty of spruce." Driftwood is fairly plentiful from Darnley Bay to Bernard Harbor in Dolphin and Union Strait, but farther east less is to be found. "Except for small quantities from the Coppermine most of the driftwood comes from the Mackenzie" (see E. M. Kindle: Mackenzie River Driftwood, *Geogr. Rev.*, Vol. 11, 1921, pp. 50–53).

At best, conditions of travel in this part of Canada are trying. One of the topographers writes thus: "Northern Canada is cursed, not by its interminable distances, its vast stretches of swamp and muskeg, its isolation, or the bitter cold of its winters; all these one can, with a certain amount of determination triumph over and acquire a fair degree of satisfaction in doing so. It is the astounding atmosphere of mosquitoes that envelops the whole face of the country in summer time that is the real curse."

Colonization in Eastern Canada. Speak of colonization in Canada, and one will naturally think of the Prairie Provinces and British Columbia. There is, however, a distinctly important colonization taking place in the east, especially in Quebec, which parallels the great march westward and northward. The two move-

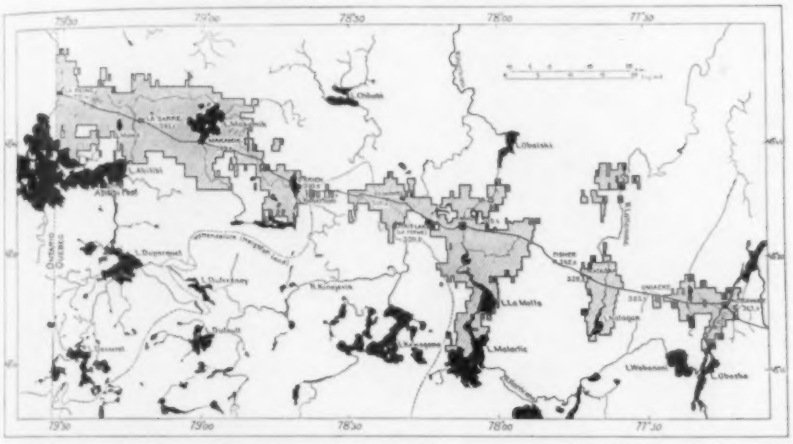


FIG. 1—Map showing settlement in the Abitibi district of Quebec, 1921. Note the concentration about the railroad. Reproduced on a reduced scale from Figure 17, *Geografiska Annaler*, 1923, p. 287.

ments are compared by Helge Nelson in his book "Canada: Nybyggarlandet" (Stockholm, 1922) and his paper "The Interior Colonization in Canada at the Present Day, and its Natural Conditions" in the *Geografiska Annaler* (Vol. 5, 1923, pp. 244–308).

Colonization in the east is of a patchy character in sympathy with the patchy distribution of areas of good soil on the ancient terrain. The "islands" of cultivation recall those of the similar terrain in Sweden, especially Norrland, and are in contrast with the prairies, where occupation of the land tends to be more uniform. Still the patches are numerous enough for us to speak of advance on a broad northward front from the St. Lawrence towards James Bay. The distinctive nature of the colonization lies in its almost purely internal character. In the whole of Quebec province the number of foreign-born at the 1921 census was only seven per cent. Expansion into the new settlement areas is due in large measure to the high excess of the birth rate over the death rate, about 20 per cent, among the French Canadians. "The most striking feature about Eastern Canada is the influence of racial characteristics in the colonization, seen in the evident energy and success of the pioneering work of the French-Canadian stock, the deliberateness with which patriotism and patriarchal interests are allowed to impress themselves upon this work, and the vitality and contentedness which distinguish the pioneering activities

of the French Canadian." Settlement furthermore owes much to the close relation with the forest. "The French Canadian is, as it were, a born pioneer of cultivation in the forests. He loves them, is a good hunter, and an unrivalled timber-cutter and worker in the woods. He is of sunny disposition, is as playful as a child, is extraordinarily contented, and holds strongly by family and kindred. These are qualities which are able to vanquish a five months' winter with up to 40 degrees of frost. . . . The colonists stick together like clay and straw. There are very few cases where settlers of other nationality and religion have obtained a footing among them."

The chief of the settlement areas are in the down-faulted region about Lake St. John and in the great clay belt. In 1920 the counties of Lac St. Jean and Chicoutimi numbered 65,000 people, practically all in the St. John and Saguenay basins. Colonization is now progressing chiefly to the north and northwest of the lake. It was the lumber industry that first drew settlement here, and the waterfalls and forest resources will continue to make this area industrial as well as agricultural. The great pulp mill of Chicoutimi has created a town of 9000 inhabitants; Jonquière has over 4800. The constantly growing region cannot yet entirely feed itself.

The greatest colonization possibilities on the Laurentian Plateau would appear to be offered by the great clay belt, the total area of which is 175,000 square miles with two-thirds in Ontario. This colonization has been dependent on the railroad. The Canadian Pacific line to Mattawa on the Ottawa River was built in 1883, the branch to Timiskaming in 1887. Colonization has spread out in a semicircle from Lake Timiskaming eastward and northward over a radius of 30 miles. The twelve parishes number 12,000 population and in the more central parts have lost their raw look and taken on the aspect of the well established French settlement.

"A remarkable colonization" is that of the Abitibi area. Before the building of the Transcontinental line in 1912 there was here only a Hudson's Bay Company trading post in addition to the Indian population. In 1913 there were 37 families numbering 329 persons; in 1922 there were 2600 families, numbering 15,085 persons. The boundary between Quebec and Ontario marks a distinct break in colonization. In the latter province true settlement is less advanced, though large-scale lumbering is in operation. Many French Canadians, however, are coming in.

Other settlement areas in Quebec, including the Matapedia district in Gaspé, which is proving attractive to settlers, are described in the Department of the Interior's publication "Natural Resources of Quebec," by M. J. Patton (Ottawa, 1923).

Study of a Glacier in the Canadian Rockies. The recently published maps of the Alberta-British Columbia Boundary Survey (Part I reviewed in *Geogr. Rev.*, Vol. 10, 1920, p. 275) afford an admirable groundwork for the glacialist who wishes to prosecute his researches in the virtually untouched field of the Canadian Rockies. One of the newly-mapped glaciers has been recently visited (1922) and described (*Smithsonian Misc. Colls.*, Vol. 76, 1924, No. 11) by Howard Palmer. This is the Freshfield Glacier 65 miles by trail northwest of Lake Louise. The reservoir of the glacier occupies a broad fan-shaped flat-floored basin in a synclinal fold of the axis of the main range of the Rockies. The surrounding heights exceed 10,000 feet in elevation. The ice discharges through a gorge-like valley to the northeast in a single ice tongue three-fourths of a mile wide and three miles long. The area of ice and *névé* in the system covers 22 square miles.

Observations were made on the daily motion of the glacier (the month was July)—the maximum rate measured was 4.83 inches—and investigations were carried out on the position of the ice tongue. Mr. Palmer reports that this glacier, like all others seen by him in the Canadian Rockies in the last fifteen years, is unquestionably in

a state of retreat. The Freshfield glacier terminates in a thin semicircular concave lip furrowed with typical longitudinal depressions. No precise data as to retreat are available, but from a photograph taken in 1902 the retreat is estimated at 46 feet a year for the twenty years.

Recent Studies of State and County Boundaries in the Western United States. A paper by Ruth L. Higgins in the *Iowa Journal of History and Politics* (Vol. 21, 1923, pp. 397–456) summarizes the history of state and territorial boundaries west of the Mississippi and may well serve as a complementary study to E. M. Douglas' revision of Henry Gannett's monograph "Boundaries, Areas, Geographic Centers, and Altitudes of the United States and the Several States" (constituting *U. S. Geol. Survey Bull. 689*, Washington, D. C., 1923; reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 160–161). Whereas the latter gives many topographical details and extensive quotations from passages in the statutes relating directly to the determination and demarcation of the various boundaries, Miss Higgins discusses the boundary changes in their historical setting. She aims to indicate not only the facts of these changes as they have been recorded on the maps but also something of the reasons behind these facts. Gannett's and Douglas' treatment is regional: that of Miss Higgins chronological. Though Miss Higgins' paper falls far short of exhausting a highly fruitful subject and, owing to its lack of maps, is sometimes difficult to follow (unless it be read with constant reference to the admirable cartograms in the Gannett-Douglas volume), it at least gives a clue to the broader influences that have guided the evolution of the primary political divisions of our West: the issues of slavery and free soil, the gold discoveries, the advance of the frontier, local politics, etc. It may be said that stabilization was finally reached with the joining of Oklahoma and Indian Territory and their admission as one state in 1906, for the admission of Arizona and New Mexico as states in 1912 involved no change in boundaries.

Geography, combined with economic and political forces plays perhaps, an even more important part in the development of the internal administrative subdivisions of a state—counties and other units—than it does in the development of states and territories themselves. Though the actual lines of county boundaries are usually determined by considerations of mathematics and astronomy, the size of the counties and the general lay-out of the county pattern at any given date are usually dependent upon conditions of settlement, which in turn are strongly influenced by natural environment. We have an interesting illustration of this in the history of county boundaries in North Dakota recently outlined by Luella J. Hall in the *Collections of the State Historical Society*, Grand Forks, N. Dak., Vol. 5, 1923, pp. 167–250. On more than one occasion in the region which is now North Dakota counties were marked out before the advance of settlement justified their establishment and, in obedience to what might almost be regarded as a natural law, were destined subsequently to disappear. Only when settlement had sufficiently progressed did new counties with new names and new boundaries reappear in the same regions. Thus, in 1862 a tier of four counties was marked out along the eastern edge of the area now North Dakota, but in the following year the act establishing these counties was repealed because "the counties were in Indian territory and consequently were not under the jurisdiction of the territorial laws and courts" (Hall, *loc. cit.*, p. 177). In laws of 1872–1873 no less than twenty-seven counties were demarcated in what is now North Dakota. This was not, however, due to any notable influx of settlers. "In order to facilitate the sale of bonds for the Northern Pacific railroad, counties were laid out and maps were made to give the impression of a well settled and prosperous region, supplying the new road with heavy traffic, and thus assuring good returns on all investments in the bonds of the road. The

capital was named Bismarck to flatter the new Chancellor of united Germany and attract the favorable notice of German capital" (*ibid.*, p. 186). In 1889, when North Dakota and South Dakota were divided and North Dakota became a state, the latter contained fifty-three counties. We may assume, however, that many of these counties in the western part of the state were of a more or less factitious nature, for in 1891 and again in 1895 the total number of the western counties was reduced. "The western half of the state was at this time devoted almost exclusively to ranching, and the unorganized counties were incorporated into organized counties in order that the large herds of cattle and horses might be effectively and adequately taxed" (*ibid.*, p. 224). By 1916, however, when the last new county was organized in North Dakota, the progress of settlement had again led to the justifiable subdivision of the counties that had been enlarged in 1891. At present the state once more, as it happens, comprises fifty-three counties; in the opinion of Miss Hall, the movement of "county organization, always a prominent [one] in a new and rapidly developing state, has almost reached an equilibrium" (*ibid.*, p. 250).

Miss Hall's paper is comparable to the studies of Owen C. Coy on California county boundaries which have already been reviewed in this journal (Vol. 14, 1924, pp. 674–675). Neither subject matter nor maps, however, have been as systematically worked out nor as graphically presented as in Mr. Coy's volumes. Another important investigation of the historical geography of counties is that of Edward B. Mathews, "The Counties of Maryland, Their Origin, Boundaries, and Election Districts," *Maryland Geological Survey*, Vol. 6, 1906, pp. 419–572.

EUROPE

Old Ports of Andalusia. Dr. Otto Jessen visited Andalusia with Professor Schulten to seek the site of Tartessos, the ancient Tarshish. Dr. Jessen's part was to look for geological evidence, and he has written a report thereon (Südwest-Andalusien: Beiträge zur Entwicklungsgeschichte, Landschaftskunde und antiken Topographie Südspaniens, insbesondere zur Tartessosfrage, *Petermanns Mitt. Ergänzungsheft No. 186*, 1924). Tartessos was not actually found, but Jessen thinks it was on a sand bar at the mouth of the Guadalquivir below Seville, much in the position of Sandy Hook with respect to New York except that Seville is four times as far up the river as New York is. A late Roman fishing village was excavated on the inside of the bar island, and Jessen thinks Tartessos may lie deep under the high dunes a little farther out.

Most of his paper consists of a minute account of the details of the region's geology, but it contains also very interesting data on the ports of southwest Spain.

The gentle curve of Spanish coast from the Portuguese frontier toward the Strait of Gibraltar is composed of a long festoon of coastal sand bars fronting Andalusia—the vale of the Guadalquivir—from the western outliers of the Sierra Morena in Portugal to the westward extension of the Sierra Nevada on the Strait.

Three Phoenician or pre-Phoenician ports dominated this coast from an early date: Huelva, ten miles up the Odiel-Rio Tinto, where the Phoenicians opened up the still important copper mines; Tartessos, the oldest, just inside the mouth of the Guadalquivir, from which the Phoenicians traded to Britain and the Baltic for tin and amber and down the African coast for ivory and gold; and Cadiz, on the first outlying ridges extending westward from the Sierra Nevada, on a rocky islet.

Huelva, founded to handle ores of Rio Tinto, has always lived for that alone. Since 1870 the new development of the mines by foreigners and the construction of railroads have given the little city—17,000 inhabitants—an active, modern life. Tartessos, enormously wealthy by its Atlantic trade and the consequent development of wine and olives in Andalusia for exportation, was destroyed by the Carthaginians in B. C. 500, its rich commerce passing to Cadiz.

The five centuries that followed were the first blossoming time for Cadiz. Always foreign, in succession Carthaginian, Roman, and Visigoth, when it came under the non-maritime Moors it quite lost importance. A second blooming time came to it a thousand years later, when the Council of the Indies was shifted there from Seville and it began to handle the very profitable Spanish monopoly of trade with America. Considerable activity animates the city today, though it is actually too maritime in its situation. Being situated on a narrow, rocky islet in the actual waves of the Atlantic, its scant five square miles of area are crowded by its 77,000 inhabitants, so that they have had to build their houses many stories high. Rail connection with the hinterland is imperfect, so that the main traffic is of passengers, freight going on up the Guadalquivir to Seville. But Cadiz too is active, unique in its lofty, tower-capped white houses, and modern of aspect since the English destroyed the city of 1596. Food and even water come to the modern town mostly by sea, a Roman aqueduct having been allowed to fall into ruin.

Back of these characteristic shore footholds of the ocean-trading Phoenicians lay Seville, 50 miles up the Guadalquivir, in the midst of Andalusia's vineyards and olive groves. Typically it was reserved for the land-developing Romans to bring it to importance, and typically in this land of burning skies and scanty rains it was for the irrigating Moors to give it its first period of high prosperity. The second came after the discovery of America with the trade monopoly fixed on the city in 1501. Today a third is in full swing under the impetus given to Andalusian trade by the construction of Spanish railroads. It is an active, modern city of 200,000 inhabitants.

While the present activity of Seville is perhaps the soundest and the most Spanish of these bursts of prosperity, the whole history of these ports is characterized by an *externalism* as great as that of Gibraltar. Spain throughout has had things done to her by outsiders. Tyre and Carthage developed the mines of the Rio Tinto and the trade on the Atlantic, the Romans and the Moors brought water and irrigation works that have declined and fallen into decay as their builders passed from the scene, the Genoese Columbus thrust into the hands of Spain the trade of an empire which she could not keep, and the present activity of mines and railroads has been inaugurated by foreigners from the north.

Even flourishing Seville has not been able to straighten her winding, shallow river by finishing works begun forty years ago to let large ships come up to her wharves, nor to build proper defenses for the city against recurring floods in the river. Cadiz cannot stir herself to sufficient activity to supply herself with much needed railroads.

It is easy to attribute all this to the sloth of the Spaniard, but he is not slothful. I am inclined to wonder if it be not rather a terrific discouragement of initiative that fortune has so many times thrust wealth into the hands of these people without bidding them to exert themselves, just as of all American countries Peru and Mexico appear to have been cursed by their abundant gold and silver.

MARK JEFFERSON

Rock Streams in the Engadine. In a paper entitled "Les coulées de blocs du Parc National Suisse d'Engadine," André Chaix describes four occurrences of rock stream of unusual type (extract from *Le Globe, Mémoires*, Vol. 72, Geneva, 1923). They were first called to his attention in 1917 in the Val Sassa at the National Park. Because of its accessibility the flow in the Val Sassa was first studied, after which the three others came under observation. Three years were occupied with the studies, 1918, 1919, and 1921. In general, each of the *coulées* consists of moraine-like material and detritus lying beyond and downstream from the glacier occupying the head of the valley. It is believed that the glaciers here had in former times a much greater

extent than is now to be observed. A previous examination by Professor Mercanton led him to believe that the movement of these flows was largely due to the lubrication between the particles furnished by the melting of remnants of ice from the earlier glacier still buried beneath the material of the *coulée de blocs*. Dr. André Chaix and Professor Émile Chaix have arrived at a somewhat different conclusion, believing that the rock flows are deposits once contained in the beds of glaciers, formerly of greater extent, and that the downstream creep of these deposits is a continuation of the original motion of the glacier. They also believe that the present glacier is not supplying fresh material.

Measurements to ascertain the rate of motion of the *couleé* in the Val Sassa showed that like a glacier the median portion of the mass moved faster than the lateral, the velocity of the former part being about two meters a year and that of the latter 0.23 meters a year. The method of determining the different rates consisted in spotting a line of stones with paint at right angles to the direction of the flow. A separate color was used for each year.

The four flows of the Val Sassa, Val dell' Acqua, Piz Quater Vals, and Val Tantermozza are described in detail, and comparisons are made with similar phenomena elsewhere. The streams of stones in the Falkland Islands, the rock rivers of the Urals, and the rock glaciers of the San Juan Mountains, Colorado, are among those compared with the Swiss flows. Chaix considers the rock glaciers of the San Juan Mountains as not greatly unlike the *coulées de blocs*.

EDWARD S. C. SMITH

AFRICA

Rural Habitations of Tunisia. In the Regency of Tunisia France directs the affairs of nearly 2,000,000 natives. An inquiry into the way they live has recently been made at the command of the Resident General. The results are analyzed by Augustin Bernard under the title "Enquête sur l'habitation rurale des indigènes de la Tunisie" (Tunis, 1924). A similar piece of work was undertaken for Algeria in 1921.

According to the inquiry Tunisia has some 66,000 city houses accommodating 350,000 persons, a city being an agglomeration of over 2000 persons. This is a high percentage (18) compared with Algeria (6): but since the days of Punic Carthage urban life has been well developed in Tunisia. The rural population is classified into four groups according as use is made of tent, *gurbi*, house, or "cave" type of dwelling (grotto and *ghorfa*). The numbers of these forms of habitation (and their users) are: tents 79,000 (419,000); *gurbis* 108,000 (572,000); houses 90,000 (477,000); grottos and *ghorfas* 19,000 (100,000).

In the northern part of the Tell the tents are few in number and chiefly those of nomads from the south: long distance migrations, however, have little place in Tunisia. Along the eastern coast the influence of the sea is reflected well to the south. From Mahrés, south of Sfax, along a line running northwest into the interior we enter the steppe region proper, and here the tent is dominant. In the extreme south, however, as the land becomes more arid pastoral industry diminishes, and the country is almost empty outside of the oases. Here the tent is occupied for part of the year only.

The *gurbi* is usually regarded as an intermediate form between tent and house; whatever the materials, it is a relatively poor type of dwelling. In Tunisia there are two main sorts, the *maamra*, found chiefly in the north with walls of masonry or *toub* and roof of thatch, and the *kib*, found chiefly in the south, a hut of branches or straw. In the north the *gurbi* occupies large areas to the exclusion of all other types. Toward the south it mingles with the tent in the interior, with the house

on the littoral. In the southern oases it forms a sort of annex to the village, and here style and usage have perhaps been influenced from the Sudan.

In Algeria three house types are distinguished—the European form, the tile-roofed house of Kabylia, and the terrace-roofed house. In Tunisia only the last, the normal type for northern Africa, is of importance. The house-dwelling population is concentrated especially in the *sahel* zone, the low fertile plains bordering the east coast and highly suitable for arborescent cultivation. The houses are grouped for the most part, the agglomeration being commonly determined by the existence of a spring. In the steppes of the center and south, indeed, this control of settlement is quite tyrannical in its operation; but even here safety has sometimes had precedence as in the *ksurs*, veritable "eagle's nests" in the southern mountains. In the island of Jerba, however, the population lives dispersed in the flourishing gardens.

In the extreme south are two remarkable types, the troglodyte dwelling and the *ghorfa*. At Jebel Dwirat caves have been excavated in the soft marly layers interspersed in the chalk cliff. At Matmata the population strictly speaking lives at the bottom of a hole. A pit five to ten meters deep is sunk in the loess; this constitutes the all-important court off which rooms are excavated. A winding tunnel leading to the flank of the hill gives an easily defended access.

The *ghorfa* is built of a series of long, narrow, low-vaulted constructions placed one on top of another, two, three, four, or more stories in height. The idea is essentially derived from the subterranean dwelling of the Matmatas. It is an artificial cliff erected in the open air. Médenine furnishes a well known example (see Figs. 7 and 8, p. 194). One might compare the cave dwellers in the loess of China who when a natural cliff is unavailable excavate a pit dwelling (see M. L. Fuller and F. G. Clapp: Loess and Rock Dwellings of Shensi, China, *Geogr. Rev.*, Vol. 14, 1924, pp. 215–226).

The usage of the several types of dwelling has undergone considerable change. Since French control has brought increased security the more permanent types of dwelling are increasing. The number of tents has generally diminished. The difficultly accessible *ksurs* of the southern mountains are being abandoned. About 40 years ago the Matmatas began to replace their subterranean dwellings by houses built above ground. The *ghorfas* are commonly used as storehouses, especially for the safe-keeping of family goods while the nomad population is away.

Exploration in the South of the Libyan Desert. Another journey breaking new ground in the Libyan desert is that made by Mr. D. Newbold (District Officer in northern Kordofan) in August to November of 1923 and described by him under the title of "A Desert Odyssey of a Thousand Miles" in the July, 1924, number of *Sudan Notes and Records*. The journey was from Bara, western Kordofan (latitude 13° 40′ N., longitude 30° 25′ E.) northwestward to Bir Natrun (latitude 18° 10′ N., longitude 26° 45′ E.).

The country south of Bir Natrun has been practically closed to travel until Darfur came into British hands in 1916 and the Arab caravans could go thither more freely to get their salt. Then "information began to trickle in of various wonders to be seen up in the corner on the map where the boundaries of Dongola, Darfur and Kordofan meet, and in the deserts beyond; a mountain of three days' journey from North to South overrun by wild sheep and with its slopes littered with relics of the aboriginal 'Anag'; a brick 'temple' like the 'temple of Jebel Barkal,' situated 15 days West of Omdurman; rock pictures engraved on cliffs and ravines; stone cairns innumerable surrounded by bones and pottery; sand-dunes that give forth reverberations like tribal drums; pinnacles of rock shaped like weird animals and *efrits;* sudden sandstorms that dry up the water in a skinbag in an

hour and drive the unwary traveler, bemused and athirst, far out of his course." The journey proved the essential truth of all these wonders.

The first part of the route (to latitude 16° 45′) was for the most part through the country grazed by the Kababish, the largest tribe of northern Kordofan and owners of 26,000 mature camels and 150,000 sheep and goats. The northern portion of their territory (from 15° 30′) is *gizzu* country, so named after species of grasses. It is a mass of old sand dunes fixed during a relatively wet period. A later return towards more arid conditions eliminated trees and thinned the bushes, but it is green with grasses from the end of the rains in September until April. The camels migrate thither for this season, spreading out over an area of some 24,000 square miles. Mr. Newbold witnessed the departure of one group of 2000 to 3000 camels. They were accompanied by young men and boys and a sprinkling of women and followed by dogs and a few donkeys who eat the *handal* melon that flourishes on the *gizzu* and resembles the *tsama* of the Kalahari. No tents were carried, but a few carpets were taken as shelters for the more luxurious. The migrants take grain with them and drink camels' milk. The Arab can live on milk for any period. He does not disdain water, however, and will remain within reach of the rock wells until they dry up. "Water is convenient for sick camels, and the Arab washes sometimes." In general, however, the camels go without water for the entire period of six months. The cold of the nights is the greatest hardship of the life on the *gizzu*.

The surface of the *gizzu* is firm, the dunes presenting gentle undulations and relatively flat tops, recalling on a smaller scale the *bulta* of the Kalahari. On the outward journey the western edge of the Jebel Tageru was skirted for 80 miles from south to north. The Jebel covers over a thousand square miles and presents a steep scarp of 300 feet on the western face. The going on the glacis of the scarp was rough and stony but was followed by the party in search of a water source. This was found four and a half days from Bir Natrun. It is a catchment of rain water which filters through the porous rock to an open-air pool in the wadi bed and dries up later in the season. From this point Barbary sheep were seen on the mountain.

Leaving the *gizzu* the expedition passed out of what the Arabs call "guaranteed" country into the "no man's land" of the desert. The Wadi Howa was crossed at an elevation of 1670 feet. This famous wadi is here a sandy valley seven or eight miles broad supporting a growth of bushes and grasses. Scattered heaps of pottery, bones, and stone implements on the northern slope of the wadi revealed the sites of ancient habitations. It may be presumed that in earlier times when a water supply was available these sites were occupied by the fashioners of the rock pictures seen at Zolat el Hammad, 30 miles farther on. The petroglyphs of Zolat el Hammad, like the ones described by Hassanein Bey at Owenat (see *Geogr. Rev.*, Vol. 15, 1925, pp. 141–142), while showing a great variety of other animals, do not include camels: hence it is deduced that they cannot be later than the first century B. C. Mr. Newbold attributes them to South Libyans, who formed the ruling caste in Ethiopia in the Merotic period. Here also were seen the curious rock weatherings of the Arab reports. East of Zolat el Hammad is the Jebel Rahib covering several hundred square miles and consisting of low ridges of blackened sandstone. It is famous for its dunes, said to utter a roar like the boom of the *nahass* or tribal drum. This instance is not mentioned by Lord Curzon in the comprehensive list of "singing sands" given in his "Tales of Travel."

Bir Natrun was approached cautiously, for it has been the scene of many encounters even in recent years. The oasis, however, was empty. It is a barren spot with two or three large salt pans, three tiny clumps of vegetation, and four distinct well areas. From a lookout the way was pointed to the large oasis of Nekheila, 75 miles to the northwest. It is known to the Arabs but has never been visited by

white man. The route from Nekheila to Owenat may be conjectured from native information and "it is probable that there are even in this inhospitable and uttermost desert one or more unknown oases."

The return journey was made along the eastern edge of the Jebel Tageru, which unlike the western border exhibits sandy slopes and is broken by defiles. At one point was found a rock well and rock pictures (no camels). Southeast of the end of the Jebel is Abu Sofian with many antiquities—rock pictures (with camels), a small brick pyramid and other ruins, and graves. Mr. Newbold believes that the archeological discoveries vindicate the theory of continued migration into the northern Sudan of desert people, "Anag" and "Abu Qonaan," from the northwest from the earliest times by which a Hamitic strain, still strongly marked, has been introduced into the southern population.

Reference might here be made to "The Dakhla-Owenat Road," by W. J. Harding King, in the February number of the *Geographical Journal*. An old caravan road runs between Dakhla and Owenat. Mr. King traced it for 200 miles. It appears to have been much traveled; and Mr. King is of the opinion that some intermediate well or oasis must have existed between the two points, which are 375 miles apart in a straight line. He suggests the best approach would be from Bir Natrun. "If the native reports are to be relied upon, there are several new places waiting to be found in this part of the desert."

POLAR REGIONS

The Amundsen-Ellsworth Polar Flight. The "Amundsen-Ellsworth Polar Flight" is being sponsored by the Aero Club of Norway. The expedition, under the leadership of Roald Amundsen, plans to sail from Tromsö, Norway, for Spitsbergen during the early spring of 1925. The Norwegian government has contributed the sum of 70,000 Kroner ($10,000) to the expedition and placed at its disposal the navy transport *Farm* (not the *Fram*). This vessel will be anchored off Spitsbergen to act as a mother-ship for wireless communication during the flight to the Pole.

The expedition is equipped with two Durnier-Wahl all-metal hydroplanes fitted with skis to land on ice. They were built in Pisa, Italy. Each plane has a spread of fifty feet and can develop 640 H. P. from two Rolls Royce motors arranged tandem. Each plane will carry three men, a pilot and a mechanic, with Captain Amundsen as an observer in one plane and I in the other. The expedition is entirely Norwegian with the exception of myself.

The expedition plans to use Spitsbergen as a base until the latter part of the summer, conducting trial flights there until the expedition's meteorologists consider weather conditions satisfactory for the trip to the Pole.

From Spitsbergen to the Pole is a distance of 600 miles, or about 7 flying hours. If a landing can be made at the Pole the expedition plans to carry out observations there for 24 hours. Should, however, any mishap befall the expedition in the vicinity of the Pole the nearest land is the Greenland coast, 400 miles away, where Captain Amundsen has a cache at Fort Conger. But, with 24 hours of daylight and an estimated sea-level temperature of approximately freezing at the North Pole for July, it is acknowledged by critics that flying conditions should be more favorable over the Arctic than over the north Atlantic during the summer months.

Upon the return to Spitsbergen, should the Polar flight prove successful, it is the desire of the expedition to attempt the trans-Polar flight to Alaska. It is 1800 miles, or about 21 flying hours across the Polar sea from Spitsbergen to Alaska.

LINCOLN ELLSWORTH

First Report of Rasmussen's Expedition. Press reports from Science Service contain the first detailed account of the Danish Fifth Thule Arctic Expedition led by Knud Rasmussen, with Peter Freuchen second in command. In the expedition's motor ship, *Søkongen*, the expedition left Copenhagen in June, 1921 (see the note in the *Geogr. Rev.*, Vol. 13, 1923, pp. 625–627). The leader returned via the United States late in 1924. Headquarters were established on "Danish Island" (Lyon Inlet) on the Arctic Circle and in longitude 83°50′ W., just east of Vansittart Island. From there parties visited the area northwest of Hudson Bay, the Melville Peninsula, the Barren Grounds, Boothia Peninsula, and adjacent areas where white men seldom penetrate. The longest and most adventurous journey of all took Rasmussen and two Eskimo companions with one sledge right across Arctic Canada from the Magnetic North Pole to Bering Strait. Every known Eskimo tribe was visited by one or the other of the parties, and the dog sledge journeys totaled 20,000 miles. It is thought that the primeval home of the Eskimos was discovered. In the headquarters region are two culture strata—an earlier stratum related to a larger and now extinct race, the Tornit, that inhabited fixed winter dwellings made of whalebone and turf and located in high situations as if on a shore line from which the ocean had receded from 30 to 60 feet. The later culture stratum is represented by the shore-dwelling Eskimos of today. Through the relatively narrow space off the northern end of Hudson Bay an immense migration seems to have taken place, as shown by the cultural elements collected by the expedition and by the large number of dwelling sites that bestrew the coasts. Of immense importance to science was the study made of the Hudson Bay Eskimo, for the extension of railways and trade to more northerly termini will inevitably destroy or alter cultural values of critical importance to anthropology. In the Barren Grounds between Chesterfield Inlet and Yathkied Lake are five Eskimo tribes, two of which inhabit the coast in the spring and summer, the remaining three being inland people who have but recently begun to move toward the sea. The sole means of subsistence of the inland tribes has been caribou hunting and salmon fishing. Stone huts are unknown, and the snow huts are unheated for want of blubber. The Padlermiut near Yathkied Lake inhabit an extremely cold and windy site. Their boats are different from the customary kayaks, and they hunt the caribou in them at the stream crossings during the great seasonal migrations. Their food supply is irregular; starvation is common, with attendant cannibalism. One Eskimo had eaten his younger brother and another his wife. By contrast the coast Eskimos go inland for the caribou season in summer but return to the coast where food is more abundant in the winter and where there can be collected a blubber supply for the lamps. The caribou skins are invaluable for clothing in a region where three days in four are marked by heavy snowstorms and a temperature ranging from −20 to −50° (C. ?).

The songs, legends, and folk-lore gathered by the expedition will serve to recreate the life of the race, and for comparative studies, with their bearing on racial origin and migrations, they are of extraordinary value. The system of complicated taboos that centers round Nuliajuk, the powerful goddess of hunting who lives at the bottom of the sea, are especially described. Of great historical interest are the Eskimo reports of earlier expeditions, for example, Ross in 1830. Fresh in their memories are the fate of the three last survivors of the Franklin Expedition on King William's Land, Rae's first visit to Pelly Bay in 1847 and again in 1854, Hall's journey of 1869, and Schwatka's journey in 1879 to King William's Land. At Starvation Cove Rasmussen buried the bones of some of the members of the Franklin Expedition.

Among the tribes west of Chesterfield Inlet toward Coronation Gulf murder is common, owing partly to accusations of sorcery, partly to the rivalry for women, whose marked scarcity is due to the strangling of girl babies. In some tribes half

of the men are murderers, and the Royal Canadian Mounted Police send out Arctic Expeditions every winter to apprehend criminals.

All the people between the Magnetic Pole and Baillie Island are even today more closely associated with the inland Eskimos than with the coast Eskimos. "The terror of the Indians is still in their blood." Many of their traditions point toward Greenland, and others toward Alaska. A surprisingly large number of their myths correspond to those known in Greenland. Rasmussen could speak with all the Eskimo from Greenland to Siberia, so similar are their dialects, a fact which suggests a common ancestry. Despite differences of habitat and the lapse of centuries there are many common qualities of speech, tradition, and folklore. Of curious interest is Rasmussen's account of the Alaskan Eskimo, who have been changed by domestic reindeer herding and the coming of sealers and whalers. Here the old songs and folklore persist though it is fast passing among these primitives: almost every man owns a schooner and is addressed as "Captain." The frame house with stove and chimney has displaced the old habitation with its blubber lamp.

PHYSICAL GEOGRAPHY

Orographic Rainfall. One of the most illuminating discussions of the rôle of mountains in the formation of rain has recently been presented from the French point of view by E. Bénévent (*Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 173–187, Grenoble). The Bjerknes ideas as developed in Norway are used and extended to explain hitherto imperfectly understood features of the rainfall of southeastern France. The relatively heavy rainfall of mountain masses compared with that of surrounding lowlands is generally known to be owing to the concentration of upward movement of winds by the mountains. There are four general types of rainfall: warm front, cold front, instability, and orographic. No explanation of the distribution of rainfall in and about mountains can be complete without some appraisal of the orographic influence in conjunction with each of the others. When a warm front approaches a mountain lying about parallel to it the cold air over which the warm is rising cannot retreat readily and so becomes more or less pocketed and continues the warm front rainfall for some time in front of the mountains. This seems to explain the considerable rise in rainfall on the French piedmont even at some distance from the mountains. When the warm front has passed and the cold air has been blown away there will still be simple orographic rainfall on the mountain face. Cold-front rains are intensified on mountain faces by the localized upforcing of the more or less entrapped warm air as the cold wedge approaching along the ground nears the mountain. And there may be slight orographic rainfall after the cold wind is established. The instability rainfalls are sharply localized where overturning or potentially overturning winds run up a mountain slope. Such rains occur when under any conditions the lower portion of the rain-making wind becomes appreciably warmer than the upper. This can happen either with a running of warm air under cooler, such as commonly occurs with warm south winds at a moderate height, or with the warming of the lower portion of an air stream in contact with the earth's surface. The localization of such rainfalls may bring 30 millimeters or more of rain in 24 hours on the windward face of a mountain as compared with usually less than 5 millimeters by orographic effects without the addition of instability. The unstable wind tends to bound over the mountains, while the stable one tends to flow around rather than go over.

CHARLES F. BROOKS

Tidal Waves, So-called. The tidal wave, so-called, may be brought about by various agencies, but excepting in name it has nothing in common with the tide; it is in no way due to the tide-producing forces, and it does not possess the periodic-

ity characteristic of the tidal movement. The appellation, however, has become so firmly established in the English language that, in spite of it being a misnomer, no other general term is used to designate the destructive waves of the sea that at times overwhelm coastal regions.

In a recent paper entitled "Les Raz de Marée" published in the *Revue Générale des Sciences* (Vol. 35, 1924, pp. 293–299) Professor Edmond Rothé of Strasbourg discusses the different types of tidal waves. He directs attention to the fact that, while the geographic configuration of a coastal region has a modifying influence, the character and intensity of the phenomena differ greatly, depending on the causes which are either meteorologic or seismic. Three general types of tidal waves are distinguished by him. The first type is that due to waves of unusual size or to unusually high stages of the water brought about by severe storms but with no indications of seismic disturbances. It is with this type that we are familiar on our Gulf coast, and as examples we may cite the tidal waves that wrought destruction to Galveston in September, 1900, and to Corpus Christi in September, 1919. In the Galveston storm of 1900 the wind exceeded a velocity of 100 miles an hour, while in the Corpus Christi storm of 1919 the wind attained a velocity of 80 miles an hour. The destruction wrought by this type of tidal wave is the result of the combined force of wave, floating wreckage, and wind.

The second type of tidal wave distinguished by Rothé is that accompanying a seaquake whose epicenter is located not far from the coast affected. If the seaquake results in the subsidence of an area of the ocean floor it is obvious that a movement of the waters towards this area must take place. Hence if this depressed area occurs at a moderate distance from the coast there will be an initial recession of the water from the shore, to be followed later by the wave that inundates the shore. The well-known earthquake of Lisbon in November, 1755, may be cited as an example. If the depressed area occurs close to the coast, the waters coming from the open sea completely overwhelm the incipient retreat of the water from the shore. In this case, therefore, the tidal wave resulting is not preceded by an initial recession of the water from the shore. Obviously tidal waves of this second type are to be looked for in coastal regions where subsidence of areas of the ocean bottom may be expected—in regions of deeps or of steep slope—as, for example, along the coast of Chile or that of Japan. In answer to the question whether the hypothesis of subsidence can be substantiated by known facts, Rothé points to the character of rupture of telegraphic cables, which frequently accompanies tidal waves of this type, as decisive proof.

Under the third type of tidal wave Rothé classes those arising from a seaquake whose epicenter is at a considerable distance from the shores affected. The destructive tidal wave along the Chilean coast of November, 1922, had its origin in a seaquake centering to the north of Chile. Similarly the tidal wave experienced in Hawaii in February, 1923, apparently originated in a seaquake near the Aleutian Islands south of Kamchatka. In such cases he is of the opinion that a wave from the region of the quake is propagated in a particular direction and that the coast lying in the path of this directed wave will experience a tidal wave. In calling attention to the fact that certain volcanic phenomena bring in their wake tidal waves he states that these always arise through the agency of a subsidence, and he instances the earthquake at Krakatoa in August, 1883, as a case in point. In conclusion he cautions against accepting the classification of tidal waves as rigid, since there are many instances which are apparently of an intermediary character.

H. A. MARMER

Plans for Oceanographic Research. The Navy Department of the United States has settled upon a project for systematic oceanographic exploration, broader in scope than previous enterprises of that type. The plan is the outcome of discussions

and conferences held during the past few years, the most important of which was convened in July, 1924, and the results made available late last year in a mimeographic report entitled "Conference on Oceanography, 1924." An impressive list of participants is given and an abstract of the remarks of all the participants. While advice was sought from unofficial sources, the members of the conference were exclusively officers of the Government.

For those who wish a shorter statement of the status of the naval plans, reference should be made to an editorial by Dr. David White, Chairman of the Division of Geology and Geography, National Research Council, in the *Journal of Geology*, Vol. 32, No. 8, 1924, pages 690–695. Here is given in condensed form the expectations of the sponsors of the plan regarding the study of plant and animal life at sea, its distribution, relative abundance and interrelations, and what a knowledge of sea life may mean when the increasing population of the world will require the methodical exploitation of oceanic food resources. Dr. White emphasizes the fact that to the geologist the principal source of interest lies in the abundant data that may soon become available on submarine topography and structure. Of course the usual physical and meteorological observations are included within the scope of the plan. In order to secure real scientific results detailed exploration will be pursued in a given region in contrast to extensive reconnaissance cruises in different parts of the world; and the conference recommends first attention to the Caribbean and Gulf regions and the exploration of the tract reaching to the Azores on the one hand, and to the Panama Canal and the Galápagos and Hawaiian Islands on the other. The results will be published by the Navy Department or under such regulations as its Secretary may prescribe.

Reference should here be made to the work of the Committee on Pacific Explorations of the National Research Council. Progress is reported in coöperation with the Navy representatives and with the Bishop Museum of Honolulu. The last-named has organized expeditions with special objects in view and with the coöperation of Naval officers at Pacific stations, though the Pacific investigations of the National Research Council are independent of the researches of the Navy Department so far as administration is concerned.

The reader should supplement the report of the oceanographic conference of the Navy with a paper entitled "Chart Making by Echo and Bomb," by Commander N. H. Heck of the Coast and Geodetic Survey, which was presented before the Board of Surveys and Maps on December 9, 1924. In it there is a further description and application of the sonic depth-finding apparatus developed by Dr. H. C. Hayes of the Navy Department and described in the Supplement to the *Geographical Review* for October, 1924. Commander Heck's paper is of special interest because of his description of the use of a sound wave generated by a bomb fired electrically near a vessel in order to determine the position of the vessel. A hydrophone is installed at a place whose position is accurately determined from observations on shore objects. By discharging the bomb from the vessel (whose position is unknown, as at night or in a fog), the time required for the sound to travel from the vessel to the hydrophone and to the shore enables the mariner to obtain his position. The results of a combination of the electric bomb and the sonic depth-finding apparatus will be a great improvement to coastal navigation. Their development in the naval research plans and otherwise will see a great extension of our knowledge of the shore zone.

Climatic Cycles and the Numbers of Animals. In every line of scientific progress there are certain periods of abundant harvest. This seems to be the case at present with climatic fluctuations. During the past generation the nature and length of climatic cycles and their various types of organic activity have been much discussed. Their effect upon animal life, however, has received less attention than their effect upon geological deposits, plants, or human activities; hence the particular

interest of Mr. C. S. Elton's contribution, "Periodic Fluctuations in the Numbers of Animals: Their Causes and Effects" (*British Journ. of Experimental Biology*, Vol. 2, 1924, pp. 119–163).

Mr. Elton begins with a brief summary of our knowledge of short climatic cycles. He believes that the evidence now leaves little doubt that cycles averaging about eleven years in length are due in the main to solar activity, although other factors may also play a part. He then proceeds to discuss periodic fluctuations in the number of animals. The well-known migrations of the lemmings are naturally one of the first topics to be discussed. The author finds that the migrations of these little subarctic rodents reach a maximum every three or four years. The animals, chiefly young ones, appear to move out from their homes because of overpopulation. They sometimes perish in the sea, across which they attempt to swim, but usually are wiped out by bacterial infections. Their migrations are "analogous to infanticide among human beings as a method of preventing overpopulation." One of the surprising things about the migrations of the lemmings is that the animals appear to migrate at nearly the same times in all the northern regions, not only in Scandinavia but in the northern parts of North America, in Greenland, and in Finland. In other places, such as the Pribilof Islands and Siberia, similar migrations take place, although exact data as to the years are scanty.

It is clear, as Mr. Elton says, that the causes of the cycles "lie either with the lemmings themselves or with their environment." It is possible to suppose that there is an innate periodicity of a rough sort in the life processes of the lemmings so that time after time it requires about the same number of years for their numbers to increase to the point where migration becomes essential and disease becomes rampant. Then the population may be automatically reduced, and the process of filling up the empty lands with a new generation of lemmings may begin once more. But such an explanation, Mr. Elton holds, "is quite untenable. It is inconceivable that such a process could cause synchronised maxima on the various mountain blocks of southern Norway, which as far as lemmings are concerned, are isolated from one another, or again in the different districts of Scandinavia. When we find further that the lemming maxima are practically synchronous all over the arctic regions and the mountains of southern Scandinavia, any such 'natural rhythm' becomes out of the question. Of course the natural rate of increase is a very fundamental factor in determining the size of periodicity into which the fluctuations will fit. The cause of the periodicity must therefore lie with the environment, and here the only possible factor which is acting in a similar way all over these regions is climate. We do not know how this climatic factor acts, whether directly, or indirectly through plants, or other animals, but there can hardly be any doubt that we have here to look for a periodic climatic effect whose period is about 3.6 years on the average, and which acts over the whole of the arctic regions and in the Norwegian mountains. It will be shown later that it probably occurs in temperate regions also."

The yearly fluctuations in the numbers of animals such as rabbits, hares, foxes, and lynxes, may be judged by the number of skins brought in by the hunters. Data of this sort are quite abundant and conclusive. They show that while these animals are more or less subject to a periodicity averaging 3.6 years, a longer period of about 11 years is on the whole much more pronounced. The same is true of mice, which sometimes give rise to genuine plagues such as that of 1581 in Essex and of 1892–1893 in Scotland.

One of Mr. Elton's diagrams (Fig. 7) shows that out of nineteen mouse plagues in Great Britain from 1810 to the present time not one has occurred during the years of maximum sun spots and only two when the sun spots were more than half as numerous as at the nearest maximum, while at least twelve have occurred when spots were close to a minimum.

The way in which the climate affects the mice is well worth studying. Mr. Elton points out four chief factors. First, mild winters favor the mice and leave an unusually large number of animals still alive in the spring to start the next season's population. Second, a mild spring with conditions of rain, temperature, and sunshine such that the old animals remain healthy and the young are not killed by undue exposure to extremes also favors a large population. Third, few things increase the population of mice or any other animals more effectively than an abundant supply of food, especially during the breeding season and while the mothers are suckling the young. This is an indirect effect of climate, for it depends largely upon plant life, a big crop of beech mast or acorns being especially helpful. The right conditions during the breeding season appear not only to favor the health of the young mice but to cause larger litters to be born. Fourth, "a favourable growing season leaves plenty of plant cover in the winter, which gives the mice protection from their enemies. There must, of course, be other factors as well. But the point is that not only are all these factors connected with climate, but the last three are all the result of the same kind of climatic complex during the breeding season."

An interesting feature of fluctuations in the number of animals is their effect on other forms of life. "One of the most striking and universal results [of the variations in the number of mice] is that the short-eared owl (*Asio flammeus*) very soon turns up and gorges on the mice. The owls often stop on migration at places which they do not visit in ordinary times at all. The number of eggs in a clutch in these years is nine to fourteen instead of four to eight, and they have two broods instead of one in the season."

Not only the rodents but fur-bearing animals such as the fisher, mink, wolverine, and skunk, and likewise many kinds of birds and insects fluctuate greatly in number from year to year. So far as data are available, cycles averaging about 3.6 and 11.2 years are dominant, no matter whether the animals are found in high latitudes or low. The beaver, however, forms an interesting exception, for its numbers remain almost constant. But the beaver, more than almost any other animal, is independent of climatic fluctuations. It does not depend on the growth of any given season, but on the bark of trees which grew long ago. When this gives out the beavers migrate. Moreover, they regulate their own water supply by building dams. The case of the muskrat is quite dissimilar. Seton says that in the Mackenzie region in 1900 he and his companions used to catch twenty in an hour after sundown, while in 1907 only seventeen were seen in six months.

Mr. Elton ends his paper by a theoretical discussion. He shows that variations in the number of animals are a peculiarly good indication of meteorological cycles, because they integrate a great number of different factors. Of course plants do this also, but variations in the growth of plants are not nearly so great or so easily detected as are variations in the numbers of certain kinds of animals. Still more important perhaps is the light which the migrations of animals throw on evolution. Suppose that a variation or mutation occurs in a few members of some group of animals. If the number of animals is large and remains so for a few generations, any variation from the standard type will soon disappear. The animals that carry it will breed with others which lack it, and the standard type will soon reassert itself. Suppose, however, that the number of animals is reduced to very small proportions. Then, if a variation occurs, it will have a chance to be preserved, for it may pertain to so large a percentage that animals which bear it may have a chance to breed together. When a period of stress ensues great numbers of animals are killed off. If the mutation is a handicap, the animals that have it are among the first to die. If it is advantageous, it may enable its possessors to survive while the others perish.

Elton's work seems to mark an important step in our knowledge of the relation of animals to their environment. It is of special interest because the periodic out-

pouring of animals from certain centers, and the enormous death rates among other species, which do not migrate, are closely parallel to what happens among human beings. The swarming of lemmings to the coasts of Norway has a certain analogy with the outpouring of the Arabs in the seventh century and of the Mongols in the thirteenth. The wholesale death of rabbits under the stress of climatic cycles resembles the wiping out of whole towns in China by famine, starvation, fever, and plague. Plant ecology, animal ecology, and human ecology are all governed by the same great laws; and all are essential to the understanding of how and why the phenomena of the earth's surface are so peculiarly distributed.

ELLSWORTH HUNTINGTON

The Geography of the Routes of Migration of the European White Stork. An adaptation of the routes of bird migrations to geographical conditions is suggested in a brief article by Armand Mercier in *La Nature* for January 31, 1925, pp. 65–67. The European white stork (*Ciconia c. ciconia* L.) breeds in spring and early summer in Germany and the Baltic countries but winters in South Africa. Details regarding its long annual journey have been gained through the ticketing of individual birds and through the observation of flocks actually in flight. The storks that nest to the east of the Weser River make their way southward through southeastern Europe, across Asia Minor, Syria, and Egypt, thence up the Nile Valley and through the East African lake region into southern Africa. The birds that breed west and south of the Weser, on the other hand, fly through France, Spain, and Morocco, whence they traverse the Sahara from northwest to southeast, following a line of highlands where there is possibly somewhat more water and vegetation than in other parts of the great desert. Storks in migration have actually been observed in the Ahaggar, at In Salah, and between Tangiers and Fez. The northward routes seem to be the same as the southward.

It has been suggested that the birds take these somewhat roundabout routes in order to avoid the difficult passage of the Alps. M. Mercier, however, declares that while this may be true of the eastern route, the western offers in the deserts as great if not greater difficulties than do the Alpine snows. Both routes avoid the crossing of bodies of water and "the detour which characterizes each, is, perhaps, due to a certain repugnance which the storks feel toward flying over the Mediterranean."

HUMAN GEOGRAPHY

The Twentieth Century Transformation of the Rubber Industry. The economic history and present rôle of the rubber industry is unique in many respects. As Fernand Maurette says in his excellent paper, "Le caoutchouc, étude de géographie économique" (*Ann. de Géogr.*, Vol. 33, 1924, pp. 409–429), it is one of the pivots of the industrial and commercial life of the two greatest powers of the globe. The British Empire produces over two-thirds of the world's rubber; the United States imports about three-quarters of the total production (somewhat higher figures are given by the *U. S. Department of Commerce, Trade Information Bull. No. 180*, 1924). It is in consequence of this situation that the Sixty-seventh Congress authorized the Crude Rubber Survey with a view to development of other sources of supply. In compliance the Department of Commerce has sent four expeditions into the field—to the Philippines, Amazon Valley, Caribbean countries, and the Far East (the last for comparative purposes). The present state of affairs has developed with extraordinary rapidity, the last decade and a half having brought about a complete transformation. "It is as far a cry from the isolated existence of the *seringueiro*

in the Amazon forests to the industrial organization of a Malay plantation as from the little workshops of the last century engaged in making waterproof garments to the great factories of Akron."

Up to 1905 only wild rubber was exploited. The output of the Amazon forests held first rank, African exploitation being less regulated and centralized and methods of collecting being still more primitive. In 1910, after the opening up of the Acre territory, the world's production of wild rubber reached its maximum with 75,000 tons, of which Brazil contributed 47,000 tons. At this date the percentage production of wild rubber and plantation rubber was 88 and 12 respectively. In 1922 the reversal was complete, being 8 and 92: the total production was over 400,000 tons. From 1900 to 1912 the taxes on rubber exported from Pará reached an annual average of $15,500,000; for the years 1913–1922 the figure dropped to $9,000,000. Today the value of Brazilian rubber exports is inferior not only to coffee, which goes without saying, but also to sugar, cotton, hides, cacao, and meat.

It was in 1876 that seeds of the *Hevea* plant were sent to Kew. These formed the basis of the great Malayan plantations. Today British Asia possesses 70 per cent of the area planted in rubber, most in Malaysia; the Netherlands East Indies 27 per cent, divided almost evenly between Java, Sumatra, and the other "Exterior Possessions." The total is 1,606,000 hectares; not all of which, however, is producing and about 30 per cent of which is owned by natives.

Marketing of the product has been equally revolutionized. The primary exporting markets of the East have taken on an *entrepôt* character; especially is this true of Colombo and Singapore. At the beginning of the century Liverpool was the first importation market by reason of her connection with the steamship companies operating to the Amazon and with the Lancashire interests in the colonies of the Guinea coast, which ranked next to the Amazon as a source of supply. In the years leading to the war there were important regional markets at Havre, Antwerp, Bordeaux, Amsterdam, and one of rapidly increasing rôle in New York. The war years and post-war years have seen the preponderance of New York in sympathy with the "monstrous" growth of the automobile industry in the United States.

In England London has taken first rank, her rôle being distinguished from that of the others by its intermediary character. The problem in the rubber trade from the English viewpoint is a double one—to assure markets for the harvest in which a vast amount of British capital is involved and not to overproduce. The problem has its agricultural and industrial aspects. An annual cultivation can be replaced, or collection of a wild product can be dropped; on the other hand, adjustments are not easy in the case of a plantation product where five or six years without remuneration are involved. Furthermore, the great bulk of the product goes to markets outside the British Empire. The problem has been solved by "one of those economic triangles so dear to the British economist."

For many years production has exceeded consumption: the post-war slump of 1921–1922 in particular resulted in an acute state of overproduction, for simultaneously much young acreage came into bearing for the first time. The Rubber Growers' Association made various efforts to secure voluntary curtailment of production but with little success. Under the stress of the recent crisis the British Colonial Office recommended the so-called Stevenson Plan to enforce restriction of export. This has been carried out in the British Possessions, but the Dutch have refused to coöperate. The measure presents the usual difficulties of artificial attempts at regulating the laws of supply and demand, as H. Stuart Hotchkiss points out in "The Evolution of the World Rubber Situation" (*Harvard Business Rev.*, Vol. 2, 1924, pp. 129–138). M. Maurette believes solution lies in the expansion of the rubber industry. Mr. Hotchkiss considers that "the pendulum is certain to swing back and forth" between shortage and surplus "until synthetic rubber comes along to upset all calculations."

HISTORICAL GEOGRAPHY

Medieval Jewish Travelers in the Orient. In a series of recent articles and notes, Paul Borchardt throws new light upon certain puzzling passages in the *Itinerary* of the great twelfth-century Hebrew traveler, Rabbi Benjamin of Tudela (in Spain), and on other early Jewish travels in the Orient. Borchardt's interpretation of Benjamin's notes on caravan routes in the Sahara appeared in *Petermanns Mitteilungen* (Vol. 70, 1924, pp. 219–223) and was reviewed in the *Geographical Review* (Vol. 15, 1925, pp. 142–143). A study of routes in Persia and Mesopotamia according to Benjamin and Rabbi Petachia of Ratisbon, who visited Baghdad about 1180, somewhat over a decade after Benjamin's visit, was published in the *Jahrbuch der Judisch-Literarischen Gesellschaft*, Frankfurt am-Main, 1924 (pp. 137–162); a brief note in *Anthropos: Revue Internationale d'Ethnologie et de Linguistique* (Vol. 16–17, 1921–1922, pp. 1056–1057) deals with caravan routes in Arabia.

Writing in *T'oung-Pao* (Vol. 23, 1924, pp. 31–35) Borchardt asserts that Benjamin does not deserve the reproach of inexactitude even in his account of the routes to the Far East. He believes that the Rabbi "mérite comme Marco Polo le nom d'un homme digne de foi," though he makes no claim that the traveler actually visited the Far East in person. We may assume that Mesopotamia was the eastern limit of his wanderings. The Ibrig, or Jabrig, of Benjamin, reached in twenty-three days from Khulam (modern Quilon on the Malabar coast), Borchardt associates with the Jambri of Odoric of Pordenone or the Lambri of Marco Polo, on the northwestern point of Sumatra. This identification seems also to be confirmed from Chinese sources. From Ibrig, Benjamin says it is forty days' voyage to Zin, or China. The Al Gingalah reached on the return voyage after fifteen days (from Ibrig, we may assume, though Benjamin does not specifically say so) may be connected with Mt. Gongalah in southern Ceylon. Benjamin's Khoulon, fifty days from Al Gingalah, may have something to do with Ghubbet Kulun on the south coast of Arabia near Makallah. This point Benjamin places at twelve days from Sebid on the Red Sea, also in accordance with the actual distance.

Interesting remarks in the writings of Benjamin and other medieval Hebrews relating to the Jewish populations in the vicinity of the southern Red Sea coasts of Arabia and Abyssinia are discussed by Borchardt in *Anthropos: Revue Internationale d'Ethnologie et de Linguistique* (Vol. 18–19, 1923–1924, pp. 258–266). The passage in Benjamin's *Itinerary* relating to these Jews reads thus, as we have translated it from Borchardt's German translation: "From there (the Arabian trading town of Sebid) it is eight days to India, which lies on the mainland called the land of B'aden . . . The land is mountainous. There are many Jews there, and they do not live under the yoke of the unbelievers but possess towns and fortresses on the peaks of the mountains, from which they make raids into the land of Haamatum, called Nubia [M. N. Adler, The Itinerary of Benjamin of Tudela, London, 1907, p. 67 (followed by J. K. Wright: The Geographical Lore of the Time of the Crusades, *Amer. Geogr. Soc. Research Ser. No. 15*, New York, 1925, p. 292) erroneously translates this "Lybia"]. Nubia belongs to the domain of the Christians. Heavily laden with booty they [the Jews] return to their homes which are inaccessible to the Christians. Jews from B'aden are found in great numbers in Persia and Egypt."

Since "B'aden" reads "Aden" in some manuscripts and is so given by translators and commentators, great confusion has arisen regarding this passage. It has been found difficult to explain how Jews of the Aden hinterlands and Yemen could make war upon the Christians of Nubia, Abyssinians, without crossing the Red Sea, or how Benjamin could have failed to mention the fact of their crossing the sea had they done so. Furthermore, at this time the Jews of Yemen by no means held the independent position that Benjamin seems to attribute to them. The

reading "B'aden," on the other hand, goes far toward solving the difficulty. This place name is recorded by the Arabic geographers under variant forms in Eritrea and northern Abyssinia. It may well persist, according to Borchardt, in the name of the coastal region of Massawa, now Ma'adem, and in that of the province of Baaden farther in the interior. No difficulty is raised by Benjamin's placing the region in India, for Ethiopia and southern Arabia were often held to be parts of India in antiquity and during the Middle Ages. The Jews, then, may be identified with the sequestered Falasha Jews of northern Abyssinia, and other topographical details given by Benjamin in relation to this part of the world fall readily into place.

To this same region Borchardt looks for an identification of the dread river Sambation of the Talmud and other early Jewish traditions as described by Eldad ha-Dani (the Danite) of the ninth century. The Sambation, or river of the Sabbath, which divided the land of the Jews from that of their enemies, was a stream not of water but of sand. It flowed six days and rested on the seventh and rolled along with it rocks the size of a house to the accompaniment of rumbling thunder. Other reports had it that the stream was one of fire or of hot steam. Borchardt shows that some of the rivers of northern Abyssinia may well have given rise to these legends. The Takazze and Abai divide the land of the Falasha Jews from the territory of other tribes: during the rainy season they flood to a depth of seventeen meters and roll great boulders down their channels with a sound as of thunder. The water is so charged with sand that it appears the color of sand, and there is a great difference between the intense cold of the mountains and the feverish heat of the deep river valleys. Even the name Sambation may be connected with that of the River Soba or Sobat.

Borchardt notes that the Falasha Jews were again described in the seventeenth century by Gerson ben Elizer as dwelling beyond the Sambation.

The Marmara Region: A Study in Historical Geography. Professor T. L. Myres's article on the Marmara Region (*Scottish Geographical Magazine*, May, 1924) abundantly illustrates the geographic principles that a strait is a gateway in a sea route and a break in a land route and that an isthmus is a gateway in a land route and a break in a sea route. Now the Marmara Region, which includes the Dardanelles, the Sea of Marmara, and the Bosporus together with their immediate coast lands, is interposed between Asia Minor and the Thracian Peninsula where these meet except for a narrow rift between; it therefore has an isthmian character. But this great land bridge connecting Europe and Asia arches over a slender belt of sea, so that the Marmara Region marks the crossroads of land and sea routes. It is a transit district, facilitating east-west and north-south intercourse. The latter has been the more important in commerce, because the Straits have linked two regions sharply contrasted in physical features, climate, soil, products and types of civilization; hence they have forwarded active exchanges between these regions since the dawn of history, and have focused on themselves the maritime policy of the commercial powers to the north and south. But the east-west route along the isthmian stretch, as an intercontinental pathway, has been swept by migrating peoples and the advancing armies of great territorial powers. The Marmara Region has been the goal of imperialistic expansion from Europe and Asia; once occupied. it has become the base for a new far-flung frontier. Such it was for the Persians under Darius and Xerxes, as for the Macedonians under Philip and Alexander. Such it was for the Roman advance headed Asiaward and the Turkish advance headed Thraceward; because land powers are habituated to movement along well explored land roads.

Hence the Marmara Region owes its conspicuous place in history to the economic and political developments in the Black Sea and Aegean lands on the one hand, and in the Balkan Peninsula and Asia Minor on the other, though in the latter case the urge for expansion may have originated in the far Danube or Tigris valleys. The

Region itself, small and limited as to resources, has played only a passive part in the struggles between the great land powers for its possession; but when sea powers were fighting for control, its rôle became a leading one. Moreover, the chief maritime cities of the Euxine and Aegean were drawn into the conflict, because they saw peril threatening their access to the abundant raw materials of the North, the forests of the Caucasus Mountains, the furs, cattle, wool, hides and especially the boundless wheat fields of the Scythian plains, which afforded food resources for industrial Greece and became therefore a prime economic condition of Greek life. Undivided control of the Straits has always been inimical to the interests of Aegean and Black Sea lands; hence the recurrent tendency to divided control as the normal and healthy condition. No state has long been able to hold the Marmara Region unless it based its strength upon a vast hinterland in Asia Minor or the Balkan Peninsula or both; or unless it pursued a generous policy in regard to its strategic passway. Any tendency to obstruct the Straits or collect tolls has invited attack. Tenure of the Marmara Region therefore has always been, in effect, a public trust. Its betrayal has aroused first protest and finally reprisal.

ELLEN C. SEMPLE

GEOGRAPHICAL NEWS

The Twenty-First Annual Meeting of the Association of American Geographers. The Association of American Geographers met in Washington on December 30 and 31, 1924, and January 1, 1925, for the twenty-first annual meeting. The meeting was held in the main building of the National Geographic Society, through whose courtesy the members of the Association and others attending the meeting were the Society's guests also at luncheon. The sessions were exceptionally well attended, and the program was characterized by careful planning. Of the forty-one papers announced all but one were read, four of these by title only. In addition there were two memorials, and a presidential and a vice-presidential address, these last two being given at a joint evening session and dinner with Section E (Geology and Geography) of the American Association for the Advancement of Science.

The outstanding feature of the meeting was the allotment of an entire day to papers on tropical geography, followed by a round-table discussion in the evening. Several papers dealt with general topics. Professor S. S. Visher of Indiana University discussed "The Rainfall Régime As a Great Handicap to Tropical Development" (to be published in the *Geographical Review*). Professor J. Russell Smith of Columbia University dealt with certain misconceptions about tropical agriculture. In the course of his remarks he referred to "The Agricultural Possibilities of the Canal Zone," by H. H. Bennett and W. A. Taylor (*U. S. Dept. of Agric. Rept. No. 95*, 1912), as an important pioneer American investigation of tropical agriculture tending to dispel such misconceptions. Dr. Helen M. Strong of the Bureau of Foreign and Domestic Commerce spoke on "Changes in Entrepôt Markets for Tropical Products." Her paper was illustrated by a map comparing the pre-war and post-war routes of tropical commodities shipped to the United States. Mr. E. S. Gregg (introduced) of the same bureau dealt with "Transportation Problems in Tropical America," referring to the technique of tropical trade with its special types of vessels —cargo, oil, fruit—and its protection against climate, especially moisture. Professor H. N. Whitford of Yale University discussed "Geographic Aspects of the Production and Consumption of Rubber." On the basis of the world-wide rubber investigation recently made by the Department of Commerce, with which he was associated, he presented a series of maps showing the distribution of rubber trees and also a map with the localities of rubber consumption in the United States. The results of the Department of Commerce investigation will shortly be published as a government

document. Mr. W. J. Showalter (introduced) of the *National Geographic Magazine* spoke on "The Monroe Doctrine and the Countries of the Caribbean."

The remaining papers of the tropical session were regional in character. Dr. C. F. Marbut of the Bureau of Soils and Professor W. H. Haas of Northwestern University both dealt with the Amazon Basin. The latter spoke on "The Physical Conditions of the Inner Amazon Basin," the former on "The Relation of the Amazon Valley to the Future Food Supply of the World" (to be published in the *Geographical Review*). Both papers testified to the value of the researches of Paul Le Cointe (see *Geogr. Rev.*, Vol. 13, 1923, pp. 634–636, and Vol. 14, 1924, p. 467) and his map of the Amazon Basin in 1:2,000,000. Mr. H. H. Bennett of the Bureau of Soils gave an address on "Some Geographic Aspects of Western Ecuador," based on a recent agricultural reconnaissance in the coastal plain and the Andean highland. Professor Preston E. James (introduced) of the University of Michigan dealt with "Geographic Factors in the Trinidad Coconut Industry." After sketching the physical basis of the industry he analyzed the conditions on an individual estate at the tip of the southwestern peninsula. Professor N. A. Bengtson of the University of Nebraska read a paper (to be published in the *Geographical Review*) on "Geographic Phases of the Industrial Development of Honduras." Professor J. Russell Smith spoke on "An Example of Local Variation in Tropical Climate," having reference to the Yuna valley in northeastern Haiti. An extra-American tropical region was discussed in a paper by Dr. H. L. Shantz of the Bureau of Plant Industry on the "Agricultural Potentialities of East Africa."

The majority of the papers of the regular program dealt with North America. Mr. W. D. Collins (introduced) of the Water Resources Branch of the U. S. Geological Survey spoke on "The Relations Between the Quality of Water and Industrial Development in the United States." Mr. Richard Hartshorne (introduced) of the University of Minnesota discussed "The Significance of Lake Transportation to the Grain Traffic of Chicago." In the ensuing discussion it was brought out that direct shipment in ocean bottoms from Great Lake ports would not be feasible in the grain trade because of the time factor. Vessels carrying Dakota wheat to Europe would not be able to return to an upper Lake port in time to load the Canadian wheat crop. Professor G. B. Roorbach of Harvard University in a paper entitled "The Relation of Foreign Trade to Present-Day New England" pointed out the varied factors upon which the recent development of foreign trade in New England is based. "The Dairy Industry of Wisconsin As an Adjustment to the Natural Environment" was discussed by Mr. G. T. Trewartha (introduced) of the University of Wisconsin. Miss Esther S. Anderson (introduced) of the University of Nebraska spoke on "The Beet Sugar Industry of Nebraska As a Response to Geographical Environment." Dr. A. E. Waller of Ohio State University told about the fixing by vegetation of the slopes of the various reservoir dams in Ohio known as the Miami Conservancy.

The admirable paper on "The Future of Alaska" completed just before his death by the late Dr. A. H. Brooks of the U. S. Geological Survey and published in the preceding number of the *Geographical Review*, was read by his colleague, Mr. R. H. Sargent. Mr. Sargent on his own behalf also described a newly discovered crater, Aniakchak Crater, midway on the Alaska Peninsula, with its six-mile-wide *caldera*. By special invitation Dr. Lauge Koch, the Danish geologist, spoke on his recent topographical and geological work in northern Greenland, referring, among other topics, as he did in his lecture before the American Geographical Society on December 23, 1924, to his completion of the circuit of the topographical mapping of the coastal margin of Greenland, to his tracing of the continuity of the ancient Caledonian mountain system of Scotland, Norway, and Spitsbergen through northern Greenland and northern Ellesmere Island (Grant Land). President W. W. Atwood of Clark University spoke on "Physiographic Stages in the Evolution of the

San Juan Mountain Region and Their Correlation with the Physiography of the Front Ranges of Colorado." Another paper on a physiographic topic was that by Mr. F. E. Matthes of the U. S. Geological Survey on "Evolution Basin in the Heart of the Sierra Nevada."

Three papers dealt with the American aborigines. In a general paper Professor W. H. Haas discussed "The American Indian and Geographic Studies." He referred to the desirability of geographic studies of Indian culture because of the relative simplicity of Indian adaptation to environment. The other two papers dealt with archeology—one by Mr. N. M. Judd of the U. S. National Museum on "Prehistoric Pueblo Bonito," the other by Mr. N. H. Darton of the U. S. Geological Survey on "Geologic Evidence As to the Age of the Temple of Cuicuilco near Mexico City." Both areas are being investigated under the auspices of the National Geographic Society.

Of papers on general geography two dealt with cartography. Professor J. Paul Goode of the University of Chicago spoke on "Progress in Cartography in Poland," calling special attention to the rôle of Professor Eugene Romer of the University of Lwów in that progress. Dr. E. L. Stevenson of the Hispanic Society of America, New York, read a paper, illustrated by lantern slides of old maps, on "Certain Erroneous Interpretations of New World Geography As Recorded in the Work of the Early Cartographers." Hydrography was represented by a paper by Mr. H. A. Marmer of the U. S. Coast and Geodetic Survey on "Mean Sea Level and Its Variations." Economic geography was the theme of the address, "A Classification of Natural Resources," by Professor N. M. Fenneman of the University of Cincinnati, retiring vice-president of Section E of the American Association for the Advancement of Science (published in *Science*, February 20, 1925).

Two papers and a presidential address were in the field of human geography. Professor Mark Jefferson's paper on Malthus appears in this number of the *Review*. In his presidential address entitled "The Promulgation, Decline, and Renaissance of Malthusianism and Its Relation to the Character and Geographic Distribution of the Soil," Dr. Marbut called attention to the fact that the present era is characterized by the opening up to agriculture of the black-soil regions of the world. This has tended to offset the increasing exhaustion of the humid soils and to postpone Malthus' predicted diminishing food supply. Professor R. M. Brown of the Rhode Island College of Education, Providence, in an interesting paper entitled "The Attributes of Civilization," pointed out the meaninglessness of a classification of peoples by racial affinities. Instead he suggested a classification by the degree of civilization, viz., into civilized, barbarian, and savage peoples. The threefold attributes of a civilized people he stated to be: collective power through organization, collective knowledge through experience, and collective sympathy. Barbarians have the outward tokens of civilization: they have collective power and knowledge but lack collective sympathy. Savages are peoples of arrested development.

Three papers dealt with regional methods. Professor Wellington D. Jones of the University of Chicago discussed "Detailed Field Mapping in the Study of the Economic Geography of an Agricultural Area," and Professor V. C. Finch of the University of Wisconsin exhibited a detailed map prepared according to the methods outlined by Professor Jones. These call for the differentiation of tilled areas (with indication of kind of crops in each case), areas in permanent pasture, wooded land, waste or idle land, streams, homesteads, transportation and communication routes, etc. In a paper entitled "Human-Use Versus Natural Regions: A Preliminary Report of the Committee on Geographic Provinces" Mr. W. L. G. Joerg of the American Geographical Society reviewed the development of the regional method with special reference to North America and broached the question as to the feasibility of including human factors in the delimiting criteria.

The general question of geographical research was discussed by President W. W.

Atwood in a paper of that title, and President Gilbert Grosvenor of the National Geographic Society gave an account of the Society's recent work and activities. Memorials were read of the two members of the Association who had died since the last meeting, Dr. E. O. Hovey (by C. C. Colby, as published in *Science*, December 19, 1924, by Professor C. P. Berkey) and Dr. A. H. Brooks (by Philip S. Smith; see also memorial by George Otis Smith in *Science*, January 23, 1925).

On the day preceding the Association meeting there was held the tenth annual meeting of the National Council of Geography Teachers. Among the papers read may be mentioned "Geography As a Social Science" by Professor George J. Miller, Secretary of the National Council; "The Ozark Region of Illinois: A Regional Study," by Miss Ina C. Robertson; and "Geographic Principles in the Study of Cities," by Professor D. C. Ridgley of Clark University (published in the *Journal of Geography*, February, 1925).

Numerous papers presented before the American Association for the Advancement of Science, which was holding its seventy-ninth meeting from December 29, 1924, to January 3, 1925, were of interest to geographers, but it was hard to hear these without sacrificing some important feature in the Association's program. For this reason attention may here be called to some of them: "The Navy's Oceanographic Program," by Mr. A. H. Clark of the Smithsonian Institution (published in *Science*, March, 13, 1925); "Determination of Submarine Configuration by Acoustic Methods," by Commander N. H. Heck, U. S. Coast and Geodetic Survey; "The Geology and Physiography of the Red River Boundary Between Texas and Oklahoma," by Professor L. C. Glenn of Vanderbilt University, Nashville, Tenn.; "The Ellsworth Expedition of The Johns Hopkins University Across the Andes of Central Peru," by J. T. Singewald, Jr., and Q. D. Singewald of Johns Hopkins University; "The Big Tree As a Climatic Measure," by Dr. Ernst Antevs; "Observations on the Mediterranean Garigue and Macchia," by Professor J. W. Harshberger of the University of Pennsylvania; "Structure of the Vegetation of Texas East of the 98th Meridian," by Dr. B. C. Tharp of the University of Texas; and "Symposium on Agricultural Conditions in Foreign Lands," embracing Great Britain, Germany, Punjab and Kashmir, Central America and northern South America, and East Africa.

The Russian Geographical Society. A brief sketch of the Society's career through the years 1918–1922, appears in a recent number of its *Izvestia* (Vol. 55, 1919–1923, Part II, pp. 173–198). Amid all its trials, the Geographical Society has kept alive and active under the energetic leadership of Professor J. M. Schokalsky, who has filled the office of President throughout the period. The formation of a new Northern Committee expresses the Society's participation in the present trend toward interest in the possibilities of North Russia. Relations have been reëstablished with most of the outlying branches of the Society cut off by the civil wars. The 1922 number of the Turkestan Section's *Izvestia* celebrates its twenty-fifth anniversary. One noteworthy achievement of the period under review is the establishment, thanks to the Society's initiative, of standard time zones in Russia, bringing the country into conformity with the international system in this respect.

A few expeditions have been organized, among which the most considerable is that of P. K. Kozlov into Mongolia and Tibet. His party set off in the summer of 1923, hoping to push its explorations as far as the upper valleys of the Yangtze and Mekong Rivers. The expedition has recently returned with a rich collection of material. Although publication has been an especially difficult matter in recent years, the Society has been able to print Kozlov's book on Tibet and the Dalai Lama and the account of his Mongolian researches of 1907–1909. Much similar material awaits the opportunity to go to press, including notes of the late N. N. Miklukh-Maklai on New Guinea and Oceania. Another manuscript ready for

publication is that of a volume of sample articles for the Society's revised Geographico-statistical Dictionary. Revision of this dictionary, of which the latest portion dates from 1885, was begun in 1919; but such fundamental changes suggested themselves in the course of the work that it was found advisable to suspend progress until a set of articles prepared under the proposed new plan could be submitted to general criticism.

J. V. FULLER

OBITUARY

FRANZ SCHRADER. Franz Schrader, the veteran French geographer, died on October 18, in his 81st year. A disciple of Élisée Reclus his geographical bent was towards the human side. For 30 years he gave courses in human geography at the École d'Anthropologie and he was the author of many geographical texts. His philosophy might perhaps be summarized from his address "The Foundations of Geography in the Twentieth Century," the first Herbertson Memorial Lecture (*Geogr. Teacher*, Vol. 10, 1919, pp. 44–53): "This ideal of Science must not be *force*, but harmony: and geography, if our hopes are not in vain, will add to the whole of sciences a large contribution to the natural and human harmonisation."

Schrader, however, will be best remembered for his cartographical work. He continued and completed (1893) the first edition of the "Atlas Universel de Géographie" begun by Vivien de Saint Martin in 1876, and brought out the new edition of this excellent work, 1920–1922. He collaborated in the "Atlas de Géographie moderne" (1890) and directed the production of the "Atlas de Géographie historique" (1896). In 1891 he initiated "L'Année cartographique," a record of new work in exploration and cartography.

Schrader's work was colored by his predilections as alpinist and painter, tastes that inspired in particular his notable contributions to the exploration and mapping of the Pyrenees. These culminated in the summary of the structure and relief of the Pyrenees written jointly with Emmanuel de Margerie and accompanied by a geological and an hypsometric map of the whole range on the scale of 1:800,000 (*Annuaire du Club Alpin Français*, 1891 and 1892). One of his earliest works was the detailed "Carte du Mont Perdu et de la région calcaire des Pyrénées central" on the scale 1:40,000 (1874). Forty years later appeared the fine map "Le massif de Gavarnie et du Mont Perdu," 1:20,000. In 1923 at the age of 79 he climbed the 2700 meters to the cirque of Gavarnie to retouch and perfect this work, the dearest to his heart, his Benjamin, as says M. Martel in his obituary notice in *La Nature* (November 29, 1924). Up to the spring of 1924 Schrader was president of the Comité d'Études scientifiques instituted by the French Alpine Club.

THEODOR KOCH-GRÜNBERG. Dr. Theodor Koch-Grünberg, latterly associated with the Museum für Länder- und Völkerkunde at Stuttgart, died of malaria at Vista Alegre, Brazil, on October 8, 1924. He had joined Dr. Hamilton Rice's present expedition which has the unknown Sierra Parima as its objective (see pp. 264–266). On his return Dr. Koch-Grünberg had planned to spend some time at São Felippe (Rio Negro) studying the myths of the Arawak tribes of the region. The leader of the expedition pays great tribute to his character—"patience, simplicity, courage, and understanding"—and scholarship. "As an ethnologist and student of the South American indigene I know no one of the present generation qualified to rank with him." He had an extensive knowledge of the native tongues of the Amazon Basin and a remarkable faculty for getting on with the natives, among whom he exercised a great influence for good. While his geographical work was subsidiary to his ethnographical studies he made important contributions to our knowledge of tropical South America. Commenting on his mapping and

topographical work, which exhibits characteristic care of detail and attention to method, Dr. Rice says "his results were surprisingly good considering the difficulties he labored under by reason of incomplete equipment, lack of trained assistance and his own rather imperfect knowledge of the subject."

Dr. Koch-Grünberg's most important published works are "Zwei Jahre bei den Indianern Nordwestbrasiliens" (Stuttgart, 1923), a revision of the two-volume work appearing in 1909–1910 and describing the results of the 1903–1905 journey in the Brazil-Colombia boundary region, and "Von Roroima zum Orinoco," a three-volume work on travels in Northern Brazil and Venezuela in 1911–1923 (Vols. 1 and 2, Berlin, 1917 and 1916; Vol. 3, Stuttgart, 1923).

GEOGRAPHICAL REVIEWS

Recent Books on Population

E. M. East. **Mankind at the Crossroads.** viii and 360 pp.; maps, diagrs., index. Charles Scribner's Sons, New York and London, 1923. $3.50. 9 x 6 inches.

E. B. Reuter. **Population Problems.** xvii and 338 pp.; bibliogrs., index. (Lippincott's Sociological Series.) J. B. Lippincott Co., Philadelphia, London, and Chicago, 1923. $2.00. 8 x 5 inches.

A. Andréadès. **La population anglaise avant, pendant et après la grande guerre.** 148 pp. ("Metron" Library; Studies of Statistics and Social Science, Ser. A, No. 1.) Soc. Tipografica Editrice "Taddei," Ferrara. 8 x 5½ inches.

Harold Cox. **The Problem of Population.** ix and 244 pp.; bibliogr., index. G. P. Putnam's Sons, New York and London, 1923. $2.50. 8 x 5½ inches.

Harold Wright. **Population.** With a preface by J. M. Keynes. xiv and 178 pp. (Cambridge Economic Handbooks, V.) Nisbet & Co., Ltd., London; The University Press, Cambridge, 1923. 8 x 5 inches.

The books quoted above, the first two being American, the last three expressing the British situation, show how seriously the question of population is affecting sociological thinkers on both sides of the Atlantic in this period of adjustment to new conditions of equilibrium. When numbers become uncomfortably large, population becomes a problem. Oddly enough, students of the matter are making their important contributions to the question of numbers not in the crowded countries of continental Europe but in America and in England (Adolf Damaschke's "Die Bodenreform," Jena, 1923, however, shows concern about one side of the question). Parts of Europe are in a condition that presents affairs more immediately urgent. Energy is there consumed in action. England and America have time to think, and their thought projects the problem of numbers as an imminent difficulty that will press with ever increasing insistence on the present and the next generations. It is a difficulty that must be faced and understood, if the conditions of living are to be maintained at tolerable standards.

The analyses presented in these volumes are strikingly alike. They converge in a definite direction. The opinions expressed are emphatic but not alarmist. Overpopulation does not impress the enlightened investigator as an actuality of widespread occurrence, but he sees in England a real overcrowding (why use the redundant term *over*crowding, when crowding expresses the idea?) and foresees there, and in America, the likelihood of serious congestion, that will submit our economic organization to a terrific stress. Overpopulation may ensue, if society does not learn to adapt itself to the pressure. Advancing study is broad. It tries to take a world view of things, but the main argument shows a natural trend of nationalism.

East's book is an extension of articles which appeared in the *Scientific Monthly*, and his strong position has not been improved by the extension, except that the volume form makes the work more widely available. The book is inclined to garrulity, but the angle from which it illuminates the problem is so novel that it must take an important place in the literature of the subject. He seems to be the only investigator who attempts to use intelligent maps, though his maps fall short of what one would desire. He is also the only worker who states plainly and to a degree quantitatively, that the habitable regions of the globe are limited in extent. His main argument is that the United States has entered the period of diminishing

returns in agriculture, while the rate of population increase is unabated. There is a lot of genetic material in the book, but, on the whole, it has a more geographical character than most books on population. Thompson, who foresaw the growth of the problem of population before America entered the war (W. S. Thompson; Population: A Study in Malthusianism (Columbia Univ. Studies in Hist., Econ., and Public Law, Vol. 63, No. 3), New York, 1915), has presented the leading results of the census of 1920 in a compressed summary (W. S. Thompson: Population Facts for the United States and Their Interpretation, *Journ. Amer. Statistical Assn.*, Vol. 18, 1923, pp. 575–587). He considers that the measured facts of a decade of increase need give no cause for uneasiness, but Rossiter (W. S. Rossiter: The Adventure of Population Growth, *Journ. Amer. Statistical Assn.*, Vol. 18, 1923, pp. 561–574) has also examined the increase of the United States, endeavoring to ascertain the growth due to natural increase of American stock and that due to immigration, and concludes that the trend is adventurous and that the consequences of the present rates are unpredictable. Reuter's book too, takes up the matter in a similar spirit, from the genetic standpoint. He is concerned with the possibility of a submergence of the desirable by the undesirable elements of the American population. He stresses America's right to determine who shall be the people to fill up her territory.

The English books are oriented towards economics rather than genetics. Andréadès, an Anglophile Greek and a student of English finance, has examined the English census and vital statistics before and since the war. He shows that the war has had comparatively little effect upon the constitution and growth of the population, the recovery from war losses being rapid. He points to two serious elements in the constitution. the large excess of females (the so-called "troisième sexe"), and the present high number of the unemployed. Cox presents the problem of crowding, in Malthusian terms, and offers several means of solution. The book has an amateur stamp; for example, we find references to excess of population, overcrowding, and overpopulation, as the same thing (see the note "Overpopulation: The Limitations of an Idea," *Geogr. Rev.*, Vol. 14, 1924, pp. 315–316); but it is a serious and well considered study, with a good deal of originality. Those passages dealing with the possibility of a more even distribution of population throughout the Empire are particularly important for their wise vision and restraint (see also Harold Cox: The Peopling of the British Empire, *Foreign Affairs*, Vol. 2, 1923, pp. 117–129; Vaughan Cornish: The Geographical Position of the British Empire, *Scottish Geogr. Mag.*, Vol. 39, 1923, pp. 217–229). Cox realizes the difficulty, as well as the desirability of so tremendous a scheme. Wright's little book is an excellent Malthusian statement from the British point of view, a clear introductory study of the subject of population. It has not a little of the geographic spirit so evident in East's volume, and, like each work in the group under review, has something to say which is not to be found in the other volumes.

Books on population make rather monotonous reading after a couple of them have been absorbed. They have a habit (except that of the statistical Andréadès) of telling you all about Malthus, his critics, and predecessors; after which they present the state of affairs today and then launch into eugenics and genetics, to finish with an advocation of birth control. Nevertheless they all seem to contain a good deal of individual wisdom. If a selection from these works be asked for, a geographer should take Wright's book as an introduction and East's as an extended treatise and with their aid could arrive at a sound realization of one of the most interesting questions of the day. As general works of reference, however, none of the volumes reviewed here can approach Carr-Saunders' masterly study of the subject (The Population Problem; A Study in Human Evolution, Oxford, 1922; reviewed in *Geogr. Rev.*, Vol. 13, 1923, p. 496) for sweep and scholarship.

M. Aurousseau

The Geography of North America

J. Russell Smith. **North America: Its People and the Resources, Development, and Prospects of the Continent as an Agricultural, Industrial, and Commercial Area.** viii and 849 pp.; maps, diagrs., ills., index. Harcourt, Brace & Co., New York, 1925. $6.00. 9 x 6 inches.

This book opens with the good Calvinistic doctrine that Hell is hot (with the reassurance in the third sentence that not all hells are hot); illustrates one of its points with a cartoon from *Life* and another with a few lines from Carl Sandburg; refers to the *Literary Digest* about as often as to the newspapers; quotes Clare Sheridan, the sculptor, and Stevenson, the essayist; illustrates successive themes with photographs from almost every important Chamber of Commerce in the United States; and explains the Grand Canyon with the help of a cross section from Fred Harvey! Which is another way of saying that the book is a continuous circus with all the side shows. It will keep classes awake. Even the trained geographer will read it through without skipping a line for, humanly, it is as interesting as a novel. We emphasize its peculiarities at the start since they illustrate one of its outstanding features—unconventionality. A second outstanding feature is its effective use of science—it really bridges the gap between technical jargon and the questing mind that must have its knowledge in plain English. Professor Smith has given us just the book that university geographical departments have needed for twenty years—a regional geography that describes and explains the real people of North America in a style that frequently displays the irresistible quality of genius.

Of all serious books of substantial worth Professor Smith's North America is perhaps the most difficult to describe in terms of a table of contents. The headings represent the bare facts of regional location. The two-page list of them is the only dull spot in the book. Every other page is filled with life, not merely the data of life. Prince Edward Island, births and deaths in a New England mill town, the boll weevil, belated winter rains in California, caribou, and sugar—all alike have a new significance. The geographical values which they exhibit well illustrate one of the most important attributes of geographical science—its point of view. It is science, it is description, it is explanation, it is in part forecast; but it is also a way of thinking. That it is a helpful and constructive way is shown on every page. Upon geography is put the task of making the earth understandable and also more habitable. Not just examples of man as the creature of environment but man confronted with problems to solve and solving them—measurably, conditionally, inventively. Above all, Smith breaks away from the deadlier aspects of pure system. No two chapters are treated alike—because there are no two regions whose outstanding problems are the same. This is a great virtue in a college text, which should excite the imagination and stimulate the creative mind. Though filled with facts regarding the soil, climate, and relief of the different regions of North America, the book reveals an author always in command of his data but rising to something more than a memory exercise. Memory alone can become a curse. Unless ideas prevail the students perish.

It is probable that a substantial list of errors could be compiled for each chapter. They will not be listed here because they are unimportant at this stage. In the next edition they should be rooted out because they are not the fit companions of great ideas and a truly original style. They are not as a rule faults of principle but of form of statement. The sure touch of a trained editor is lacking. References are not always accurate. There is more than a trace of exaggeration here and there. Stefansson will not approve page 660. Many of the maps are bad; a few are atrocious. The idea of breaking up Lobeck's block diagram of the United States (excellent for its original purpose) into regional units is unsound from any standpoint

and an offense to the cartographic eye. Perhaps we expect too much of an author with so vast a field to cover; it is probable that no one man can cover it definitively; a monographic treatment by regions still wants doing. We hesitate to offer even these minor criticisms for fear that the reader may be diverted from the high qualities of the book—at one and the same time a really standard text and a work of art.

The Vegetation of Eastern Bolivia

Theodor Herzog. **Die Pflanzenwelt der bolivischen Anden und ihres östlichen Vorlandes.** viii and 258 pp.; maps, diagrs., ills., bibliogr., indexes. (Die Vegetation der Erde, No. 15.) Wilhelm Englemann, Leipzig, 1923. 10 x 7 inches.

The publication of a new volume in the great series dealing with the vegetation of the earth, for which Professors Engler and Drude are responsible, is an event always to be welcomed. But the appearance of this, the fifteenth, by Dr. Theodor Herzog is specially important for two reasons: first, because with the earlier works in this series by Reiche and Weberbauer and with the more recent paper (*Petermanns Mitt.*, 1922) by the latter, it provides a complete regional botanical survey of the whole of the Central Andes and, secondly, because the eastern slopes and piedmont of the Central Andes, which form Dr. Herzog's field, are shown by him to be a key area in the plant geography of South America—the meeting place of plant formations differing greatly in character and of floras of widely different origin.

Geographically Herzog's work is particularly valuable and remarkable because he is himself one of the few explorers upon whose results we must rely for the very elements of our geographical knowledge of this little-known part of the continent.

The author's introduction to the country was an expedition undertaken on behalf of a development company in 1906–1907. From their point of view the results were entirely negative, and the investigation was curtailed in consequence. The journey had begun at Puerto Suarez on the Rio Paraguay, in a district reputed to produce coca trees which did not exist; thence westward through the rain forest east of the Rio Blanco in the province of Velasco in search of rubber. But this forest explored as far north as 15° S. revealed nothing but inferior rubber species. The author then traversed the plains westward by Santa Cruz to the outer cordillera to the west of it, to report upon the possibilities of cinchona production; but the *montaña* forest was found to have been largely denuded of cinchona trees by earlier gatherers. The foothills here were also said to yield "yerba maté"; but Herzog found that the product was fraudulently so-called, since it was derived from a quite different shrub. These negative facts are in themselves interesting to geography; and science has gained more than commerce lost by that expedition.

The second expedition (1910–1911), undertaken on his own account, had purely scientific aims not entirely confined to botanical work, for Herzog carried out a compass survey over a long distance and made geological and meteorological observations as well. The surveys have been made use of by this Society in the compilation of the La Paz and Santa Cruz sheets of its map of South America. The route lay from Ledesma in northern Argentina along the eastern foot of the Andes and the western fringe of the Gran Chaco to Santa Cruz, but with diversions eastward from Yacuiba to the Rio Pilcomayo and up this river to Villa Montes, as well as westward to examine the forests on the eastern front of the Andes and the more xerophilous vegetation of the ridges and valleys behind the front range. From Santa Cruz the author made a journey along the foot of the mountains where they make their great bend to northwest and also penetrated these unknown ranges. Later he began his long journey westward, following in general the usual pack trail from Santa Cruz to Cochabamba but often diverging to south and north.

From Cochabamba the exploration and survey of the high plateaus and upper valleys to the northwest were carried out, and later similar work was done in the Cordillera de Quimsa Cruz—the part of the Cordillera Real south of the Rio de La Paz; but unfortunately these surveys were not connected.

The book now published, after an introductory account of the expeditions and a bibliography of 91 entries, opens with a chapter on the physical geography of Bolivia. The section of this which deals with the orography and hydrography is probably the most accurate brief statement that has yet appeared regarding the Andes east of the meridian of Oruro. The author commits himself to a statement of the climatic conditions with great diffidence, pointing out the almost complete absence of reliable observations; but he has rightly decided to include a brief treatment of climate in its broader aspects.

The main portion of the work is divided as follows: a brief description of some features of the leading plants represented in the country, treated by natural orders, with mention of their position in localities and in plant formations (36 pp.); a summary of the vegetation types by regions and formations (5 pp.); a description of the natural vegetation, region by region, including discussion of the floristic compositions and their probable genesis (151 pp.), followed by three pages on the plants in the service of man. The work concludes with a list of endemic plants and two indexes. It is illustrated by excellent photographs, by four diagrammatic profiles showing the altitudinal distribution of formations, and by two maps. The first of these shows the floral provinces and extension of key genera and species between latitudes 9° and 26° S. and from central Peru eastward to beyond the Rio Paraguay; the second, which is of larger scale (*c.* 1:2,250,000), is a vegetation map showing the distribution of the ten leading formations from the Bolivian Altiplano eastward to the plains and between latitudes *c.* 16° 30′ and 19°.

The parts of Bolivia studied by the author are divided from the vegetation standpoint as follows:

(a) The Puna of the Altiplano—Tola heath with yareta in the drier parts, vegetation thinning southward and salt desert increasing.

(b) Zone of the eastern summits—Alpine grassland, semi-xerophytic on the inner side, mesophytic on the outer, near snow line cushion and rosette-like plants.

(c) Eastern basins, including a huge area of plateau and valley within the bend of the Rio Grande reaching northward nearly to the limit of its drainage and transgressing this to include the head valleys of the Yapacari—cactus and thorn bush with thin xerophytic woodland.

(d) Northeastern slopes of the Andes (north of 18° S.)—*montaña* rain forest, subdivided into (1) lower (*yungas*) up to *c.* 1500 meters, characterized by palms; (2) middle *yungas* to *c.* 2400 or 2800 meters, characterized by cinchona, tree ferns, coca, and coffee cultivation; (3) cloud forest (*ceja de la montaña*) to 3400 meters, characterized by ericas, myrtaceae, and epiphytes, especially mosses and ferns. This is essentially the same as the formation in Peru and western Bolivia described by Weberbauer and others. The altitudinal limits are described as varying, being higher on high ridges and lower where summits are lower.

(e) Eastern marginal cordilleras (18°–25° S.)—deciduous forest, green in the (summer) rainy season; palms absent.

(f) Piedmont north of 18° S.—savana, consisting of macrotherm and partly xerophytic forests separated by grassland.

(g) Gran Chaco—alternation of *monte* composed of succulents and thorn bush, grassland, algarrobo (*Prosopis*) woods, and palm (*Copernicia*) groves. This is in character allied to (c), and it is incompletely separated from (e).

Geologists, physiographers, botanists, and zoölogists are fast amassing evidence bearing upon the life history of the Andes as a mountain system. Herzog's contribu-

tion seems to be a large one. It rests upon his analyses of the flora and his conclusion regarding the sources from which it has been derived. It is for botanists to judge whether the evidence justifies these conclusions. But whether the conclusions are the right ones or not, the evidence remains to be dealt with in relation to the data of geologists and of other biologists. Without attempting to follow here the author's arguments in regard to the flora, it may be useful to summarize his conclusions.

The Altiplano and still higher plateaus and mountain slopes of the Central Andes are occupied by a flora composed of Andean genera commingled with others of Boreal and Austral-Antarctic origin; the proportions given in a list of leading genera being respectively 9:7:2. The proportion of Boreal types is highest in the mesophytic grass formation on the eastern (moister) slopes above the tree line. This composition is explained by the well-grounded hypothesis that, at least for a long period following the maximum glaciation, the high cordilleras served as a cold bridge, along which plants spread toward and beyond the equator from far north and far south. It seems likely that some of the endemic Andean plants are derived from ancestors which inhabited the older pre-Andean surfaces of lower altitude.

The mountains and valleys below the Altiplano level apart from the well-watered front ranges are occupied by a xerophytic flora made up of general Neotropical elements together with a large assortment of purely Andean plants which bear a strong resemblance to the Mexican flora. This kinship with the north is one of the striking facts of plant geography. The author considers the evidence of existing continuity from the Ecuadorian Andes through Central America to Mexico as insufficient, and prefers to regard the florae as once continuous but now severed by climatic—and presumably tectonic—causes. The main area of this, the Valles flora of others and here called the Inter-Andean xerotherm flora, lies east of the southern Altiplano in the drainage basins of the Rios Grande, Pilcomayo, and Bermejo.

The Sub-Andean flora of the *montaña* forest is to be regarded as "unitary" from the Northern Andes to 18° S. The Bolivian part of it is made up primarily of endemic plants but contains elements from three other floral provinces, the proportion being in the following order: (1) Central Brazilian, (2) Equatorial Brazilian, including Guiana and the West Indies, (3) Austral-Antarctic.

In discussing the flora of the forests (including the *montaña* above mentioned) on the outer northeastern and eastern slopes of the Andes, the author likens the bend in the ranges about latitude 18° S. to a great headland projecting into an ocean. Towards this there came a steady stream of species from the plant reservoir on the ancient land mass of the central Brazil highlands, which here approaches most nearly to the Andes, a projection—the sandstone ridges of Chiquitos—offering a bridge, early emerged, to give westward passage to the plant life. This vegetable stream, striking the Andean headland, divided; and Brazilian genera have spread northwestward, commingling with the Sub-Andean flora of the *montaña*, and southward to form the preponderating element in the marginal Sub-Tropical forests of the eastern cordillera. On the mountain slopes southwest of Santa Cruz the Brazilian and Sub-Andean elements are in equilibrium.

The Hylaea (evergreen rain forest of Amazonia) is not discussed separately in this work, but elements from this formation are described as tongues projecting southward along the main rivers into the other formations, and merging into the *montaña*. The piedmont and plains about Santa Cruz exhibit great variety floristically as well as in their vegetation. The trees and bushes of the savana are mainly Central Brazilian; plants from southern Brazil and northern Argentina dominate the grassland; while the presence of *algarrobo* and *chañar* trees points to a migration from the southern Chaco.

One of the most interesting conclusions arrived at is that the vegetation of the Gran Chaco is in the main composed of elements derived from the xerotherm flora of the lower Andean plateaus and valleys, and this in spite of an intervening zone

of Sub-Tropical forest, whose chief origin is Central Brazil (as mentioned above). Yet it is less surprising when the climate of the two regions is remembered, for conditions of rainfall are essentially similar. The Chaco plains became dry land long after the eastern Andes, and it is clear, therefore, that the parent flora must be that of the mountains and not that of the Chaco itself. The author, while pointing out how little of the Chaco is known, yet finds sufficient evidence that Andean genera predominate; and so we may accept virtual Andean origin for these well-nigh impenetrable expanses of woodland and *monte* brush, as we do for the soil upon which they grow.

A. G. OGILVIE

SOUTH AMERICAN TIMBER

S. J. RECORD AND C. D. MELL. **Timbers of Tropical America.** xviii and 610 pp.; ills., index. Yale University Press, New Haven; Humphrey Milford, Oxford University Press, London. 1924. $10.00. 10 x 7 inches.

The second part of this valuable report, entitled "The Trees and Their Woods," by the senior author, and consisting of nearly five hundred pages, is a distinct contribution to our knowledge of the timbers of tropical America. It is admittedly not the last word on the subject but ought to do much to stimulate efforts to obtain material for further research.

Unlike the great majority of works on the subject this report has had for its basis first-hand knowledge of a collection of woods comprising some seven thousand numbers (some with authentic botanical material obtained from the same tree) that has been deposited in the working museum of the Yale School of Forestry.

In arrangement, the treatment of the woods is by natural orders, or families. This includes a brief description of the wood characters of the family as a whole, followed by a more detailed treatment of the principal woods that belong to them. After a discussion of the commercial importance of the woods, sometimes with historical references, there are semi-technical descriptions of some one or more specific woods that belong to the groups and long lists of commercial and local names under which the woods are known in the various regions in which they occur.

These lists are valuable also because they show the geographical range of the different species or groups of species. Thus, it is pointed out that mahogany, known locally as caoba, consists of not one, as is generally believed, but of five known species and that this group is confined to the northwestern section of tropical America, viz. the West Indies, southern Mexico, Central America, and, in South America to Colombia, Venezuela, and perhaps Ecuador. On the other hand, the Spanish-cedar group, known locally as cedro, consisting of more than thirty species, is found in every political unit from the West Indies and Mexico to and including Argentina.

The first part of the report, entitled "The Countries and Their Forests," by the junior author, and comprising eighty pages, is intended as a setting for the second part. While it has many good points, much of importance is lacking.

Considerable space is devoted to the physical features of each of the political units, much of which could have been better expressed by maps; but in many instances one does not get a good idea of the distribution or character of the forests.

There are indications that the author depended too much on his personal impressions and not enough on the literature of the subject. Thus, in speaking of the coastal region of Brazil, he states that "mangrove skirts the coast . . . covering vast (*sic*) areas in the north and also in São Paulo" (p. 73). On the same page there is an overemphasis of the extent of the savana areas; and again, still referring to the coastal region, the author says, "That portion of the belt from Bahia to Uru-

guay includes the true agricultural land of Brazil . . . The region as a whole includes the present commercial and economic forests of Brazil" (pp. 73–74). By these two statements the author seems to exclude the Brazilian highlands, where the present agricultural wealth is located and where the only large-scale logging in all tropical America is being conducted.

As a matter of fact there are three economically important forested regions in Brazil.

1. The Amazon region, which the author disparages and states is not at the present time commercially important, is not only the largest area in hardwood forests in Brazil but in the world. Although the cut of timber here at present is comparatively small, the Amazon region is exporting more timber than the coastal region, and some of its lumber reaches this latter region. If rubber, Brazil nuts, and palm nuts are included with lumber, more forest wealth is being produced in the Amazon than in the coastal region.

2. The forests of the highlands, especially those from São Paulo south to and including the northern part of Rio Grande do Sul, contain hardwood and mixed coniferous and hardwood forests. It is in the latter that the largest lumbering operations are being carried on. The highlands not only furnish most of the timber used by this important agricultural district but send considerable quantities to the coastal region; comparatively large amounts also are exported, mainly to Uruguay and Argentina. No other lumber region in South America is so important as this at the present time.

3. The hardwood forests of the coastal belt have been badly cut over for agricultural purposes. While the amount of hardwood lumber being cut here is in excess of that exploited in each of the other two regions, at the present time this is barely sufficient, because of the crude system of logging in practice, to meet the local demand for it. With the introduction of more modern lumbering methods, the output could possibly be raised to such an extent that there would be large quantities for export.

H. N. WHITFORD

LIFE IN SCANDINAVIAN LANDS

GUSTAV BRAUN. **Die nordischen Staaten: Norwegen, Schweden, Finnland: Eine soziologische Länderkunde.** 138 pp.; maps, ills., bibliogr. Ferdinand Hirt, Breslau, 1924. 9½ x 6½ inches.

An excellent little book of the traditional German character for regional geography, but an astonishing failure to apply the plan proposed in three pages of introduction and conclusion.

It gives a good description from geology to occupations and history of the people, with more than usual reference to possible human interests. The language is clear and the matter interesting. There are 45 admirable half-tones. Some things omitted might be lamented but for the fact that a second volume is to come, either as a whole or in parts for each country. This second volume is to dissect the countries into economic units and study these units in action.

The plan which the author proposes in his introduction, *but utterly fails to carry out*, was to make a country's exported and imported wares the threads that he would trace back to the life of the people and the nature of the land environing them. For 70 of his 106 pages you get no statement even of exports and imports. The table at page 70 is utterly crude and undigested. In the first place it is for 1913. Some apology may be made for that, but Dr. Braun does not make it. To illustrate its indigestibility: Norway exports 132 million kroners' worth of "food of animal origin." You can infer from some of the comments that part of this is cattle products and part of it fish, but not *what* parts.

The admirable volume "Norway," published by the Government in 1900 for the Paris exhibition, gave the needed data, which Dr. Braun could undoubtedly get today; namely that in 1898 the exports of fish were of value 45 million kroner, of fish in tins 1 million, of butter and margarine 3.6 million, of condensed milk 4.6 million. There you have matters set out in true proportion, and most interesting threads might be traced back to the people in their homes. In western Norway the cattle in those days were sent up to the mountain *saeters* as long as the pastures there were free of snow, while down below every possible blade of grass was harvested and stored away, together with the tops of the potato plants and the tips of the young birches, as cattle feed for the long winter. The farmers trimmed the grass around rocks and trees with their little sickles as carefully as the barber trims your hair. Grass was obviously precious. You are not surprised to learn that no poultry was kept—hens scratch up so much grass! So the eggs consumed in western Norway were "made in Germany."

It is to be hoped that Dr. Braun will follow his proposed plan in the volume to come.

MARK JEFFERSON

A SWEDISH SCHOOL ATLAS

ALFRED SÖDERLUND, edit. **Svensk Skolatlas, I: För Folkskolan.** 16 pp. of maps. Skriv-och Ritboksaktiebolaget, Stockholm, 1924. 12 x 9 inches.

Swedish art and Swedish geography alike should be crowned with laurels for this little elementary school atlas of a dozen principal maps and a dozen minor ones.

Beautiful colors, marvelous offset-printing with its perfection of color registration, clear delicate outlines, scholarly selection of details, and the use of fresh, new methods characterize the book.

I should call the beauty of the maps its first "feature." The second is the representation of all large cities by the self-explaining size symbols—spheres—that Sten De Geer has made familiar in his great map of distribution of people in Sweden (see *Geogr. Rev.*, Vol. 12, 1922, pp. 72–83) and Söderlund has also used in his similar map of Norway (reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 646–647). These spheres of solid contents proportional to the size of the city fix on the observer's mind an inescapable impression of the dominance of New York in North America, of London in Britain, though they show duly the importance of Chicago and Glasgow, of Paris in France, and the coequal size of Madrid and Barcelona in divided Spain. The third feature is the set of little continent maps of products in pleasing tints and a clearly elastic legend.

Söderlund and his coworkers do not fail to utilize modern advances in knowledge, for instance upwelling waters where we used to represent cold currents in the "Labrador Current," "California Current," and "Humboldt Current," on the hemispheres map. Railroads are marked on all maps but the hemispheres. All the maps are political but have an expression of relief at once simple and excellent. Five continents have the same scale, 1:40,000,000, with Europe double size.

The American eye is not much pleased with the strong black lettering of country names, almost as strong as on French school maps. But the pedagogy is doubtless sound. Children are to have those names fixed by seeing, and they must make no effort to see!

The black names are utilized to distinguish independent countries. Africa shows them only in Egypt, Abyssinia, South African Union, and Morocco. Algeria lacks the bold vivid name. So do India, Java, and British Guiana.

As far as I know this is the best school atlas produced anywhere.

MARK JEFFERSON

The Story of Lake Ragunda

H. W. Ahlmann, C. C. Caldenius, and R. Sandegren. **Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning.** viii and 119 and 91 and 55 pp.; maps, diagrs., ills., bibliogrs. In Swedish with German résumé. *Sveriges Geol. Undersökning*, Ser. Ca, No. 12, 1924, Stockholm. 12½ x 9½ inches.

Ahlmann's and Sandegren's papers were originally printed in 1915, but almost the entire editions were destroyed by fire in 1922. When Caldenius' part was completed in 1924, Ahlmann's paper was reprinted practically unchanged, Sandegren's paper after revision.

Lake Ragunda was situated in the valley of the Indalsälven River in northern Sweden (63° N.). It was catastrophically drained in 1796, and its deposits were deeply trenched when its waters were directed across the partly excavated drift barrier blocking the pre-glacial river channel.

Ahlmann treats the whole geomorphological history of the lake and the development of the region after the drainage, giving detailed descriptions of the conditions at successive stages.

Caldenius treats the clastic deposits and their records. During the uncovering from the last ice sheet, outwash and varved glacial clay were deposited in the lake basin. Later, delta sediments and varved post-glacial clay silts were laid down. Part of the finest material went through the lake. The varve curves show good agreement with each other; but it has not been possible entirely to eliminate local influences and thus to obtain a curve of the relative annual snowfall.

Sandegren undertook a stratigraphic and chronologic investigation of the plant remains in the lake deposits, whose layers are dated almost exactly in relation to the bisection of the ice rest and with very fair accuracy in relation to the Christian chronology, Gerard De Geer having recently succeeded in connecting the Ragunda chronology with Ragnar Lidén's post-glacial chronology in the valley of the Ångermanälven. Sandegren's study of the evolution of the climate of the region is unrivaled in accuracy. Plant remains are plentiful. The most important fossil localities occur in the central parts of the ancient lake. The remains consist of wood, bark, cones, leaves, fruits, seeds, etc. Leaves of deciduous trees densely packed at places form layers resembling cardboard.

The geological history of the region is shortly as follows. When the ice sheet withdrew from the district the present valley formed a deep and wide fiord of the Baltic, which registered a shore line now lying about 240 meters (787 feet) above sea level. In this fiord at first glacial varve clay, later post-glacial varved clay silt were deposited. The oldest plant remains, representing *Betula odorata*, *Pinus silvestris*, *Populus tremula*, and *Alnus incana*, occur in varves 620 to 630 after the bisection of the ice rest. Rising of the land progressed, and about varve 800 the lake became isolated from the Baltic by a barrier of glacial drift. In varves 1230 to 1240 there appears a flora of the same temperate character as that nowadays found in the region. *Ulmus montana* and *Stachys silvatica* may be especially mentioned. About varve 1300 Lake Ragunda was isolated by a rock sill. During the time 1780 to 2730 there existed in the region a rich flora indicative of higher summer temperature than prevails today. Already at this time or during the Atlantic period, that is about 7000 to 6000 years ago, the post-glacial temperature maximum was reached. Then the following plants, whose present northern limit of distribution lies farther south, flourished in the region: *Carex pseudo-cyperus*, *Corylus avellana*, *Lycopus europaeus*, *Solanum dulcamara*, *Stachys silvatica*, and *Ulmus montana*. About year 3700 Lake Ragunda was saturated with sediments, and the Indalsälven became localized to a trenched channel in the deposits. This evidently marks the end of the Ragunda chronology. Shortly after a drought period set in, and the high-water

level of the lake, previously regulated by a rock ledge, sank probably about two meters (6.5 feet). This is shown by occurrences of peat bogs in depressions within the former lake area and by the sequence of strata of these bogs. Subsequently, in connection with an increase in precipitation and fall of temperature, the lake again rose to above the rock ledge, and the warm-climate flora retired southward. The drought period is the sub-boreal period, and the preceding and following moist periods are the Atlantic and sub-Atlantic periods respectively.

ERNST ANTEVS

THE NEW EDITION OF DE MARTONNE'S PHYSICAL GEOGRAPHY

EMMANUEL DE MARTONNE. **Traité de géographie physique.** 4th edit. Vol. 1: **Notions générales, climat, hydrographie.** xi and 496 pp.; maps, diagrs., ills., bibliogrs. Librairie Armand Colin, Paris, 1925. 10 x 6½ inches.

It is a high privilege to review a good book. Professor de Martonne's "Traité" was a distinctive and scholarly work in its first edition; and by three successive revisions, the last the most thorough of all, he has made it perhaps the most useful work of reference in physical geography in any language. To those familiar with the organization of similar works in America it is necessary to point out that while types of climate, lakes, rivers, seas, etc., are discussed in de Martonne's book, the richness of the text is chiefly due to the effective use of the principle of comparison. This is not the result of accident but of design. In the first chapter is an admirable expression of modern geographical doctrine, and it is worth special attention because the author has really put his philosophy into effect. He states (p. 24) that geography has a character which is essentially scientific and philosophical but that there are also realistic and descriptive qualities, and it is only in the combination of all four that we have geography as a distinctive modern science. He considers that there are three essential principles of geographical method: (1) distribution or extension, (2) comparison, or what we might call sorting or classification, and (3) the explanations of things. Geography, in his view, is the only science that studies the distribution of phenomena of the surface of the earth and that links them to general laws whose effects are then sought elsewhere. The combinations of local or regional influences have to be known in a manner in which the physicist, the botanist, and the statistician do not know them. That is the geographer concerns himself with the surface of the earth as a great laboratory where a surprising variety of regional types are found. With the characteristics and courses of these types the geographer is chiefly concerned. He is not interested in distribution as such, nor with the distribution of all things, but with distributions that point the way to general laws that affect man and his activities.

In the first part of the fourth edition (the only part yet published) the major space is given to a section on climate. In fact, this section makes a considerable handbook in itself, and, while it does not have the originality displayed in the sections dealing with land forms (as treated in previous editions), it is eminently satisfactory as a well-balanced treatise from which there has been removed every unnecessary paragraph and sentence, thus giving an effect of close organization and what one might call high speed to the clear, well-balanced discussions of successive phenomena and climatic types. The two maps at the end of the volume represent thorough revision as compared with those in the three preceding editions. In the world map showing the relief of the lands and of the sea floor the latest topographical surveys have been embodied in most instances. Similar care has been exercised in the revision of the climatic map. Both maps are in color. The climatic map has a fundamental change in terminology besides a reduction from twenty-seven to twenty-six general types. The effect is one of great improvement since in general

the local names that formerly designated types have been displaced by broader regional names. For example, the Ukrainian type of climate of the earlier editions becomes a "steppe variety," and the Polish climate becomes "continental." It is important to emphasize these changes because the present edition should be purchased by everyone interested at all in referring to de Martonne's method of treatment or to the facts and principles of geographical science. There has been a fifteen to twenty per cent increase in the number of bibliographical references. The number of figures in Part I has been increased from one hundred and sixty-five to one hundred and ninety-three as between the third and fourth editions. Upon both the large colored maps at the end of the volume as well as upon a number in the text, but particularly Figure 153, it is hard to understand why the north-eastern corner of Greenland has not been completed on the basis of the topographic work of the Mylius-Erichsen Expedition. We point out the omission only because it is one of the important major additions to cartographic knowledge since the appearance of de Martonne's first edition. In one of the divisions of the climatic bibliography are thirty-six items on climate of which ten relate to local winds, such as chinook and valley winds, though there is no mention of W. M. Davis' standard work on the sea breeze. In the list of references on water, King, 1899, is mentioned, but not Slichter, whose "Motions of Underground Waters" (*U. S. Geol. Survey Water Supply and Irrigation Paper No. 67*) is now a standard book. The reviewer can find no reference to M. F. Maury's classic "The Physical Geography of the Sea" (1855). In any general discussion of ocean currents and the atmosphere there ought to be some reference to Benjamin Franklin, just as the section on cyclonic storms ought to bear the name of the most original contributor to the subject: William Ferrel, "A Popular Treatise on the Winds" (1889). No doubt these few suggestions have been considered by the author and have been rejected for good reason. They merely express the reviewer's judgment that a general book like de Martonne's should include them, especially a book so broad and thorough in its treatment and so truly international in its dependence upon references to the leading languages of science.

Weather Notes for the General Reader

C. F. Brooks. **Why the Weather**? With the Collaboration of John Nelson and Others. xvi and 310 pp.; diagrs., ills., index. Harcourt, Brace & Co., Inc., New York, 1924. 7½ x 5 inches.

Popularized science, Dr. Brooks calls it, for general readers who want to know more about the weather. Very bright and taking it is, offering a wealth of interest on weather matters. Witness the fresh and vigorous account of boiling temperatures in Bolivia, the vivid portrayal of the ice storm of November, 1921, in New England, not to mention the delightful test of likelihood of summer thunderstorms according as the relative humidity is over 70° (likely) or under 60° (unlikely), if it may be trusted, and all the details of actual weather of 1923, elucidated by parallels from earlier records. Dr. Brooks is admirably informed of the weather happenings of this country, and the book is limited to that. A man need not be ignorant of the weather and its science to find the book useful.

The explanations read easily. The whole book does that. Dr. Brook's note of certitude helps. He tells exactly what happens to a hailstone throughout its history, where a writer like W. M. Davis contents himself with stating what the circumstances suggest for its origin, which is a less popular method.

The reviewer is free to confess that he has not the omniscience proper to a reviewer, and that meteorology has for him a charming collection of unsolved problems. None of these, however, does Dr. Brooks happen to solve in this book.

The explanation of lightning at page 130 looked promising but did not prove very convincing, nor is there in the book any reference by which to refer to "Lenard" for the fuller argument.

Incompleteness of explanation and looseness of language are characteristic of too great a part of the book for entire clarity. Possibly perfect clarity was not aimed at. Perhaps the aim was rather a treatment suggestive of the causes at work. Possibly Dr. Brooks does not care much for precision of language. At any rate water vapor in the air he refers to indiscriminately as water vapor, water, or moisture (pp. 22 and 23) exactly as the "ordinary reader" would; but that is a loose way of talking, and I think the popular value would not be hurt by sticking to the precise name water vapor when that is what is meant. Incompleteness of statement is noted in the author's story of Quervain's ingenious use of a black bag which he filled with snow and hung on his sledge in the sun as he crossed the Greenland ice cap, thus getting drinking water at all times even when the temperature was well below freezing. The explanation lacking is some account of the difficulty experienced by previous explorers in getting drinking water on the same ice cap. Nansen gave a vivid account of it, I think—nothing but snow at freezing temperatures and much thirst, which could only be satisfied by halting and setting up a tent as shelter from the wind and lighting a lamp to melt enough snow for a drink. This was so much trouble that the travelers were always thirsty, and when the border of the inland ice was reached and running water was met, every one rushed to it and flung himself down on his face to drink.

The explanation of asphalt mirage (p. 108) is incomplete and loosely worded, "the refraction acting in effect as would a mirror." That is something refraction cannot do.

To pick out the true horizon where hills mask it (p. 151) by selecting a "point level with the eye" is not possible. Probably Dr. Brooks means to guess where the horizon is, the method being very rough. It is not true (p. 189) that "water flows down the slope, the air along it." Can it be meant that water runs so slowly in most cases that rotational deflection does not affect it very much, especially as it is usually entrenched between confining banks? Many of us have looked for deflection in the flow of streams on land, and the ocean currents are very generally supposed to be subject to it.

Is there some other account of Franklin's discovery that northeast storms come from the southwest than that contained in Franklin's letter of February 13, 1749-1750? Franklin does not tell the story as Brooks does. It is unfair to this very great American scientist to say (p. 180) "Franklin noted what may have seemed to him an anomaly: the northeaster always arrives from the southwest." We do not have to guess how it seemed to Franklin. He printed a clear account of his observations and his most acute reasoning from them a century and a half ago.

It would not have needed very much attention to have removed blemishes like these—all, I fancy, the result of carelessness—from a book that withal is likely to stimulate interest in meteorology more than any other book ever written.

MARK JEFFERSON

SIR NAPIER SHAW ON WEATHER FORECASTING

NAPIER SHAW. **Forecasting Weather.** 2nd edit., revised and enlarged. xliii and 584 pp.; maps, diagrs., ills., indexes. Constable & Co. Ltd., London, 1923. 36s. 8½ x 6 inches.

Sir Napier Shaw, throughout a long period of professional service, has been a busy man; and, although he has now withdrawn from the directorship of the Meteorological Office and other duties more or less official in character, he is still unmistakably busy, and his pen more productive than those of many of his juniors.

Somehow he has found time to give us a second edition of this work which first appeared in 1911. The many developments incident to the war made extended revision necessary. Forecasting weather suddenly in 1914 took its place as part and parcel of the great game. Sir Napier hints at this when he writes, "The few aeroplanes and airships which represented the national equipment of the Air Services of 1911 became multiplied into thousands of aeroplanes and a complete patrol of the British coasts by airships; innumerable kite-balloons with standard winches and other gear for manoeuvring them were at the service of those who wished to explore the upper air."

Yet in the book not much space is given to examples of the application of forecasts. There are three chapters, XV, XVI, and XVII, which treat of forecasts for aircraft, forecasts for air and sea, particularly visibility, and forecasts of land fogs; but otherwise the discussion is along academic lines treating the physical processes of weather.

Copies of the latest codes for transmission of weather reports are given, and, inasmuch as radio sets are quite general, it is now an easy matter for the laity to "listen in" and get not only the forecasts but the code messages used in making up the map. He laments with justice, we think, that the information now poured into the Daily Weather Report is so ample that it causes embarrassment. His humor comes out in the remark, "The situation which confronts us is that of a computer who is faced with the solution of a number of simultaneous equations. The calculation is quite an exhilarating exercise when the number of variables is two; it becomes rather tedious when a third variable joins with its equation; when there are ten any ordinary computer recoils from the task, and when there are twenty he seeks some other occupation."

Owing to new demands, specific information of hitherto unnoticed conditions must be obtained and distributed; and we have, as our author states, now reached a stage where seven or eight thousand entries are required for the full discussion of the weather of a single day. Unless this mass "is peptonised in some . . . way there is some danger of its causing indigestion." 'Tis well said. The weather map of the British Isles is a small affair compared with our American weather map, and some readjustment might well be made in the presentation of temperature and pressure data.

The book is written for British readers, and in consequence of this many of the maps will have but a passing interest for American readers. We can not very well ask the author to rewrite the treatise, but undeniably it would contribute much to an intelligent appreciation of aerography in this country if author and publishers could arrange in a third edition to extend the field by including a few memorable storms of the United States. True, we have an official treatise on forecasting, published eight years ago, and there is much meat in it; but a modern treatment of the subject is needed. We have some interesting developments of anticyclonic control in this country; and as for cyclones, we know them in their entirety—quite different from those of the British Isles, which, as Sir Napier says, "are hardly with us long enough to develop real personal acquaintance."

It is not easy to single out special chapters for commendation, where there is so much that deserves praise; but to those of us who have to explain to students the relations of pressure, temperature, humidity, and airflow, Chapter VIII (The Physical Processes of Weather) is particularly helpful. Sir Napier Shaw sets forth so clearly the processes of dynamical heating and cooling, that what in other hands too often is hard and dry reading becomes easy and most attractive. Fascinating perhaps is the right term to use, for, rightly interpreted and told, there is no story that can surpass in romantic interest this tale of the changes always in progress in the air around us.

ALEXANDER MCADIE

A Working Manual on Analysis and Prediction of Tides

Paul Schureman. **A Manual of the Harmonic Analysis and Prediction of Tides.** v and 416 pp.; diagrs., ills., index. *U. S. Coast and Geodetic Survey Special Publ. No. 98.* Washington, D. C., 1924. $1.00. 9 x 6 inches.

The advantages of specifying the tide at any place by means of harmonic constants are gradually becoming more widely recognized, while the superiority of the harmonic method for the prediction of tides is attested to by the fact that the tide tables issued in advance annually by the various maritime nations for the use of the navy and merchant marine, are being based more and more on the harmonic method. In this country the harmonic method is used altogether in the preparation of the tide tables issued by the government.

In the preface to his volume Mr. Schureman states that it was designed primarily as a working manual for tidal computers. It is divided into three parts. Part I, after an introductory section giving a brief historical statement and a general explanation of harmonic analysis and the equilibrium theory, deals with the tide-producing forces, the derivation of the various tide components, and the prediction of tides. In this part the processes for the harmonic analysis and prediction of tides are given in considerable detail, and attention is called to the applicability of the harmonic methods to tidal currents. It contains also a good description of the tide-predicting machine used in the preparation of the tide tables issued by the United States Government. Part II consists of forty tables for facilitating the analysis and prediction of tides. A number of the factors employed in the harmonic method vary from year to year, and in these tables Mr. Schureman gives the values for each year from 1850 to 2000. Part III lists the harmonic constants of the tide for some 800 places throughout the world.

The volume deals with a highly specialized process which is described in but few publications. In this country there has been no publication devoted to the harmonic method of tidal analysis since the appearance in 1898 of Part II of the "Manual of Tides" by the late R. A. Harris, and this has been out of print for some time. Students of tides will find Mr. Schureman's volume a very useful publication, the matter being presented clearly and with sufficient detail. They will find particularly useful the table of harmonic constants which lists the known harmonic constants for the entire world. Many of these have not heretofore been published, and for those that have been published the student was compelled to search through a number of scattered reports and memoirs.

H. A. Marmer

German Political Geography

Zeitschrift für Geopolitik. Edited by K. Haushofer. Monthly. Berlin-Grunewald. Vowinckel, 1924.

Karl Haushofer and Josef März. **Zur Geopolitik der Selbst-Bestimmung: Südostasiens Wiederaufstieg zur Selbstbestimmung; Das Schicksal überseeischer Wachstumsspitzen.** 503 pp.; bibliogr., index. Rösl & Co., Munich and Leipzig, 1923. 8½ x 5½ inches.

The Swedish scholar Rudolf Kjellén, who died in 1922, was one of the leading modern proponents of the theory of the state as a living, "biological" organism. The influence of his writings, particularly of the "Staten som Lifsform" (first published in 1916 and translated into German under the title "Der Staat als Lebensform," 4th edition, Berlin, 1924), has been felt particularly in Germany. Indeed, it might almost be said that a definite German school of politico-geographical theory founded upon Kjellén's work has sprung into being.

Geopolitik was the name applied by Kjellén to those particular aspects of geography and political science concerned with the relation of the state to its geo-

graphical environment. The founding of a monthly periodical in January, 1924, the *Zeitschrift für Geopolitik*, devoted exclusively to the cultivation of this subject, bears witness to the widespread interest which has been stirred by Kjellén's work. Professor Karl Haushofer of Munich, the editor, frankly announces that the aim of this journal is the encouragement of investigations along the lines mapped out by Ratzel and Kjellén. He defines *Geopolitik* as "the science of the political forms of life in their areal relations, in their relations to the earth's surface, and as influenced through historical movements." Nearly all the articles are informative and original, sections are devoted to "geopolitical" news and books reviews, and the text throughout is enlivened by outline maps and cartograms. The titles of some of the leading articles will give an idea of the subjects covered: "The Unity of the Monsoon Countries," "The Mediterranean Seas as Geopolitical Areas of Power," "The Rhine and Danube as Fashioners of States," "The Fundamentals of European Commerce," "The Japanese Earthquake and Its Political Results," "The Geopolitical Structure of Brazil," "The Treaty of Versailles and Political Geography."

A new-found belief in the sanctity of self-determination, which has recently made itself evident among German writers on political topics (see *Geogr. Rev.*, Vol. 14, 1924, p. 666), is also expressed in many of the articles in the *Zeitschrift für Geopolitik*. More notably, however, it forms the central theme of Haushofer's monograph on "The Reawakened Movement Toward Self-Determination in Southeastern Asia," which constitutes the first part of the volume referred to above (the second part being contributed by Professor Haushofer's pupil, Josef März). Here the editor of the *Zeitschrift* has set himself the task of analyzing comparatively and in their geographical relationships the various far-eastern movements toward self-determination. Through a geographical study of the sentiments prevailing in the Orient in favor of self-determination, of the varying aptitudes of the different Eastern peoples for its enjoyment, and of the varying degrees to which they actually possess or are deprived of it at the present time, Haushofer believes that he may arrive at positive conclusions bearing upon the grave problems confronting contemporary Germany. As a study of conditions in the East the essay is in many ways a constructive contribution to geography. The author's comparisons and analogies between the Far East and Central Europe, however, seem overdrawn. Haushofer regards the "monsoon lands," stretching from northern Japan to the western borders of India, as a climatic and anthropogeographic unit: he presents interesting, if evasive, generalizations upon the influences that geographical environment has presumably here brought to bear upon political consciousness and upon the inhabitants' capabilities of maintaining or achieving independence. He concludes, reasonably enough, that, however potent geographical forces may be in affecting the conditions of self-determination, the *will* to attain independence in the last analysis is of first importance.

CORRESPONDENCE

Submarine Topography off Monterey Bay

Cambridge, Mass.
November, 1924

To the Editor of the *Geographical Review:*

The *Review* for last April contained an account by C. R. Longwell of a fault map of California in which the submarine topography south of San Francisco is taken from a chart, No. 5194, published by the Hydrographic Office in 1923; and it is noted that a "canyon-like trough heading in Monterey Bay is represented as continuing oceanward to a depth of 12,000 feet." It is true that the chart shows the submarine contours at 100-fathom intervals turned in, some of them very sharply,

toward the middle of Monterey Bay down to the 2000-fathom level; but an examination of the original large-scale chart on which the individual soundings were plotted and the contours drawn makes me doubt whether the submerged canyon really exists. The soundings off that part of the coast were made by the recently perfected Sonic Depth Finder—an echo sounding apparatus—installed on the U. S. Cruisers *Hull* and *Corry;* the depth was determined at points about a mile apart on lines ten miles apart trending square out from the coast. Near the shore of the bay a number of earlier soundings, combined with those made by the above-named cruisers, define the occurrence of what seems to be a submerged valley of erosion with considerable accuracy down to depths of more than 500 fathoms; but farther offshore, where the in-turned contours from 1000 to 2000 fathoms lie between two lines of new soundings, there is only one earlier sounding in the included area of about 300 square miles: there the in-turning of the contour is truly enough permitted by the depths thus recorded, but many other contour patterns are also permitted; and the recorded depths do not suffice to determine which pattern is the correct one. Hence, until additional soundings are received, the deeper part of the canyon as now contoured should not be regarded as a demonstrated submarine feature.

Farther south, where the lines of soundings are only five miles apart, the contours are of course more trustworthy, and the revelation of the many and pronounced inequalities of the sea floor in that region is highly instructive. Yet even there the chart could be more safely used if the position of each sounding had been indicated by a dot; for it would then have been possible for each student of the chart to see for himself where the contour lines are well established by the lines of soundings and where they are unguided across the intervening five-mile belts. The chart as published gives the lines a uniform authenticity all along their courses and thus greatly lessens their value in critical investigations.

W. M. DAVIS

Hydrographic Office, Navy Department
Washington, November 26, 1924

To the Editor of the *Geographical Review:*

In appreciation of your invitation, issued at the instance of Professor W. M. Davis, to comment upon his note on the canyon-like trough heading in Monterey Bay, the accompanying copy of a portion of Hydrographic Office Chart No. 5194 has been prepared to indicate the bathymetrical data from which the configuration of the Monterey trough has been drawn.

The lines of soundings in the Monterey region by the U. S. S. *Corry* and the U. S. S. *Hull* are indicated by the straight lines drawn at right angles to the general trend of the submarine topography. The distance apart of the soundings on each of these lines was between one and two miles, and the bathymetrical contours shown on the chart have been drawn in conformity with the depths that were measured along these lines.

In addition to the lines of soundings by the *Corry* and the *Hull* were the two lines of deep-sea soundings on rhumb and great-circle courses from Monterey Bay toward the Hawaiian Islands, taken by the U. S. S. *Albatross* in 1891 and 1892 (see *52nd Congr., 1st Sess., Senate Exec. Doc. No. 153*, pp. 9 and 18).

Besides these, the abundant soundings shown along the coast line of Monterey Bay in Coast and Geodetic Survey Chart No. 5402 served for the delineation of the contours down to the depth of 1000 fathoms.

As partaking of the nature of confirmatory evidence concerning the Monterey trough, there have been gathered since the publication of Hydrographic Office

Chart No. 5194 in March, 1923, determinations by the U. S. S. *Corry* in running along a north-and-south line across the trough in September, 1924. These soundings are shown on the chart underlined.

The feature which, by Professor Davis' assertion, should not be regarded as demonstrated is that which is depicted within the area overlaid by dashes. Whatever may be the modification which future accessions to bathymetrical data may

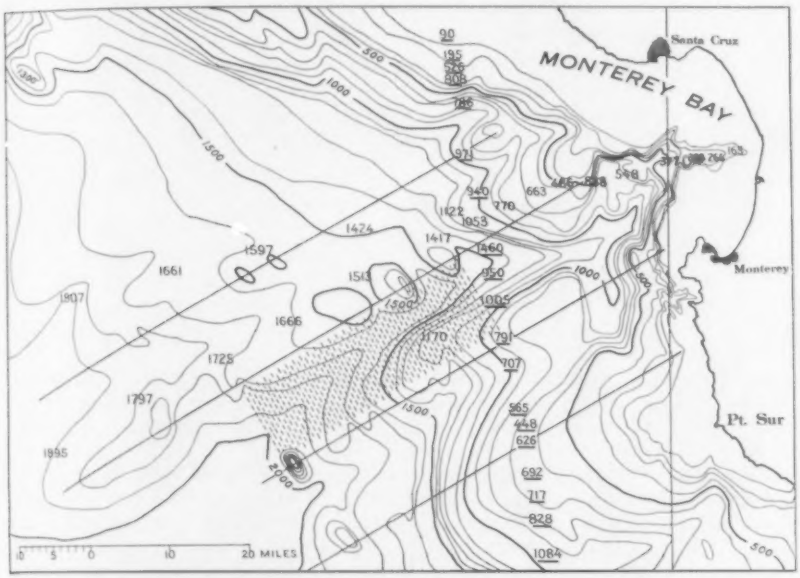


FIG. 1—Reproduction on a reduced scale of a portion of Hydrographic Office Chart No. 5194. The data mentioned in Captain Bassett's letter and a scale of miles have been added.

impose upon this part of the delineation, it would not seem to impugn the evidence of the existence of the submerged canyon to which ingress lies open by ascending gradations from the incurved contour of 2000 fathoms on a course to the northward and westward of the hatched tract containing the contours of configuration in relation to which doubt has been expressed.

F. B. BASSETT
Hydrographer

THE ISLE OF PINES

Dr. Thomas Barbour, of the Museum of Comparative Zoölogy, Cambridge, Mass., sends us the following comment on the Isle of Pines (see the note in the January *Geographical Review*, p. 137):

"The southern region is of uplifted eolian limestone, much eroded. Here at several points are small bays and the only deep water anchorages near the island, all of the other coasts being accessible to small boats only, on account of the extensive flats and shoals. In general this region remains little known. North of the great swamp in the southern portion of the island a considerable area of land has been cleared and devoted to citrus crops by American colonists with conspicuous lack of success, and great sums of money have been lost in these ventures. Many of

the plantations are now abandoned and reverting to wild lands. A few Americans continue to visit the island on account of its fine climate, most of the other regular visitors being the promoters of schemes for selling or reselling the so-called citrus fruit lands. It is possible to grow citrus fruit where there is sand, provided sufficient fertilizer is obtainable, but the marketing of the crop is both difficult and precarious. Large areas of the northern and central parts of the island are composed of the so-called savana lands formed of disintegrated igneous rock, supporting a few spindly palmettos, a little bunch grass, and a few indigenous shrubs. This vegetation will not support any grazing animal."

Dr. Barbour has visited the Isle of Pines collecting and on intelligence work frequently over a period of many years.

The Isle of Pines Treaty by which the United States relinquishes all claim of title to the island in favor of the Republic of Cuba was ratified on March 13, 1925.

The Automobile in the Sahara

Boston, Mass., January 29, 1925

To the Editor of the *Geographical Review:*

I have just read with great pleasure Mr. Gautier's article on "The Trans-Saharan Railway." Last winter my wife and I made the trip by automobile from Tozeur to Tuggurt and from Tuggurt to Ghardaia.

The Compagnie Generale Transatlantique were running à fairly regular service between Tozeur and Tuggurt, spending the night at El Wad. The Citroën Company, I was informed by the local French authorities, ran a car once every two weeks between the two points.

With regard to speed, the Renaud six-wheel cars, which are really twelve-wheel cars as each of the three axles carries four ordinary wheels on it, make in the sandy desert not over twelve or fifteen kilometers an hour. On the hard desert between Wargla and Tuggurt and Wargla and Ghardaia they could not make above twenty to twenty-five kilometers. I timed them for myself, and during the last part of the Wargla to Ghardaia journey we were driving against time.

As far as I could discover, for desert work there was not much choice between the Citroën and the Renaud cars; both of them would navigate sand into which a man would sink above his ankles perfectly easily and would take grades of at least 30°. The caterpillar cars I was told could not compare in speed over the hard desert with the Renaud cars. In the sand the speed of both of them was about the same. Even with automobiles five hundred kilometers of hard desert without a drop of water or a blade of grass is a very hard test.

There can be no question that the automobile can go anywhere in the Sahara, given a supply of water and a supply of gasoline at fixed points, and it can do the work much quicker than the camels can, but it is necessarily tied down by the requirements of water and gasoline.

Yours truly,
Ellerton James